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PERUVIAN BARK.

A POPULAR ACCOUNT

OF THE

INTRODUCTION OF CHINCHONA CULTIVATION INTO BRITISH INDIA.

By CLEMENTS R. MARKHAM, C.B., F.R.S.

1860–1880.

With Maps and Illustrations.

LONDON.
JOHN MURRAY, ALBEMARLE STREET.
1880.

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PREFACE.

THE enterprise undertaken by me in 1859, of introducing the cultivation of Peruvian bark trees into British India and Ceylon, is now an assured success. The work was commenced in 1860, and two years afterwards I published a narrative of my travels, which comprised an account of my work in South America with this object in view, and of that of my fellow-labourers, as well as reports on the selection of sites for plantations in India, and on the first commencement of cultivation.*

During twenty years the enterprise has since steadily progressed. There are now 847 acres under chinchona cultivation in the Government Plantations on the Nilgiri Hills, besides 4000 acres of private plantations on the Nilgiris, in Wainad, Coorg, and other hill districts of Southern India. In British Sikkim the Government chinchona plantations cover an area of 2242 acres. The annual bark crop from Government Plantations of British India alone is already 490,000 lbs. In Ceylon 5578 acres were under chinchona cultivation in

* "Travels in Peru and India while superintending the collection of Chinchona plants and seeds in South America, and their introduction into India," by Clements R. Markham," 8vo., pp. xvii. and 572. Maps and Illustrations. (Murray, 1862.)

1877. In 1879–80 the quantity of bark sold in the London market, from British India and Ceylon, was 1,172,060 lbs. The East India source of bark supply is now the most important but one as regards quantity; and by far the most important of all as regards quality. On the Nilgiris the whole expenditure has been repaid with interest, by the sale of bark in the London market, and the Government is now deriving large profits of many thousands a year from the bark harvests. In Sikkim the true object of the undertaking has been better understood, and the plantations are utilised for the supply of a cheap and efficacious febrifuge to the people of India. In 1879 there were 7007 lbs. of this cheap febrifuge manufactured.

The time has now come for presenting to the British public a complete history of the enterprise, in a concise form, from its commencement in 1860 to the year 1880. In future years the introduction of the fever-dispelling chinchona tree will be one of those measures for which British rule will be entitled to the gratitude of the people of India. It is, therefore, right that its history, and its results, should be familiar to Englishmen, as well as to the educated classes of India. After acquainting themselves with the difficulties of the undertaking in the First Part of the following pages, and with its results in the Third Part, I venture to ask my readers again to peruse that chapter in the Second Part,* which records the treatment of those gallant men

* P. 271.

who, amidst perils and hardships of no ordinary kind, performed the work by which India will be so largely benefited. Those who did the work have not received fair recompense for most valuable services. But the work itself has conferred an inestimable blessing on the people of India, while it has, at the same time, become a remunerative public undertaking.

CLEMENTS R. MARKHAM.

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PART I.

COLLECTION OF CHINCHONA PLANTS AND SEEDS IN SOUTH AMERICA.

CHAPTER I.

PLAN OF THE WORK.

THE whole world, and especially all tropical countries where fevers prevail, have long been indebted to the mountainous regions of the Andes for that inestimable febrifuge which has now become indispensable, and the demand for which is rapidly increasing throughout all civilised countries. There is no drug more valuable to man than the febrifuge alkaloid which is extracted from the Chinchona trees of South America; and few greater blessings have been conferred on the human race than the naturalisation of these trees in India and other congenial regions, so as to render the supply more certain, cheaper, and more abundant.

It is the object of the following pages to relate the measures which I adopted to obtain collections of plants and seeds of febrifuge Chinchonæ in the various regions in South America where the most valuable species are

found; to give an account of their introduction into India, and of the hill districts in that country where plantations have been formed; and to record the history of Chinchona cultivation in India from its commencement down to the present time, a period of twenty years.

In this short opening chapter I am anxious to impress upon the minds of my readers the great importance of the introduction of Chinchona cultivation into India. Fever is by far the most prolific cause of death, carrying off, except in abnormal years when cholera is raging, very many more than all other diseases and accidents put together. The total number of deaths from fever in India is upwards of a million and a half annually. At least half these deaths will eventually be prevented by putting some cheap form of the Chinchona alkaloids, retail, into every *pánsarí's* shop in the country at one rupee per ounce or less; and thus countless multitudes will be saved from death or grievous suffering. If rightly considered, this measure is as important as any other question connected with Indian administration, for it involves the annual saving of many lives, of large sums of money, and of an immensity of misery.

The successful introduction of Chinchona cultivation into India, the measure which is destined in the time to come to secure such beneficent results, was a task of considerable difficulty in all its stages; for it was not only necessary to transplant a genus of plants from one side of the world to the other, it was also an essential element of success to convert wild into cultivated

plants. This involved a close study of the climate, soil, and general physical aspects of each region where the valuable species grow in their native forests; a comparison of these circumstances with those prevailing in the East Indies; the discovery of the best species, and also of the species best adapted to secure good results in their new homes; the study of all the requirements of the plants under cultivation without any guide, as the Chinchonæ had never been cultivated before; and finally the solution of numerous very complicated questions relating to the best and cheapest form in which the febrifuge can be provided for general use. The task was difficult and complicated; but before beginning to tell the story of how this task was performed, step by step, painfully and anxiously, but always zealously and hopefully, it is desirable that the reader should have a general knowledge of the Chinchona trees.

In the first place, therefore, I propose to relate the history of the discovery of the virtues of Peruvian bark, with a plea for the correct spelling of the name, of its first introduction into Europe, and of the opposition to its use. I shall then give some account of the first botanical investigations connected with the Chinchona genus, of the early trade and destruction of trees, and of the region in the Andes where the trees flourish. My next object will be to convey to my readers a correct general idea of the characteristics of a true Chinchona, of the number of valuable species, and of the nature of the bark and of the febrifuge alkaloids which are extracted from it. My last preliminary work will be to

describe each region of the Andes separately where the valuable species are found, with some account of their discovery; and to relate the circumstances connected with the introduction of Chinchona trees into Java by the Dutch, an enterprise which, in point of time, preceded my own undertaking by a few years.

These introductory chapters are essential to the due comprehension of this interesting subject; and necessarily precede my account of the arrangements which I set on foot for the introduction of all the valuable Chinchona species into India.

CHAPTER II.

KNOWLEDGE OF FEBRIFUGE BARK AMONG THE INDIANS.

THE aborigines of South America appear, except perhaps in one locality, to have been ignorant of the virtues of Peruvian bark. This sovereign remedy is absent in the wallets of itinerant doctors, whose *materia medica* has been handed down from father to son, since the days of the Yncas. It is mentioned neither by the Ynca Garcilasso de la Vega, nor by Acosta, in their lists of Indian medicines. It seems probable, nevertheless, that the Indians were aware of the virtues of Peruvian bark in the neighbourhood of Loxa, 230 miles south of Quito, where its use was first made known to Europeans; and the local name for the tree *quina-quina*, "bark of bark," indicates that it was believed to possess some special medicinal properties.* The Indians looked upon their conquerors with dislike and suspicion; it is improbable that they would be inclined to impart knowledge of this nature to them; and the interval which elapsed between the discovery and

* In Quichua, when the name of a plant is reduplicated, it almost invariably implies that it possesses some medicinal qualities. In some parts of Peru the Indians use the word *quina-quina* for the balsam-tree (*Myrospermum*).

settlement of the country and the first use of Peruvian bark by Europeans is thus easily accounted for.* The conquest and subsequent civil wars in Peru cannot be said to have been finally concluded until the time of the Marquis of Cañete in 1560; and Jussieu reports that a Jesuit, who had a fever at Malacotas, was cured by Peruvian bark in 1600.† M. de la Condamine also found a manuscript in a library of a convent at Loxa, in which it was stated that the Europeans of the province used the bark at about the same time. Thus an interval of only forty years intervened between the pacification of Peru and the discovery of its most valuable product.

It may be added, however, that though the Indians were aware of the febrifuge qualities of this bark, they attached little importance to them, and this may be another reason for the lapse of time which occurred before the knowledge was imparted to the Spaniards. Referring to this circumstance, La Condamine says: "Nul n'est saint dans son pays." This indifference to,

* La Condamine, Jussieu, and Ruiz, all believed that the Indians were aware of the medicinal qualities of Peruvian bark, and that they imparted their knowledge to the Spaniards. Humboldt and Ulloa were of an opposite opinion. The stories of its virtues having been discovered by watching the pumaa or South American lions chewing the bark to cure their fevers, mentioned by Condamine; and of an Indian having found it out by drinking of the waters of a lake into which a Chinchona tree had fallen, told by Geoffroy, are of modern and European origin.

† Jussieu says that it is certain that the first knowledge of the efficacy of this bark was derived from the Indians of Malacotas, some leagues south of Loxa.—*Weddell, Histoire Naturelle des Quinquinas*, p. 15.

and in many cases even prejudice against, the use of Peruvian bark, amongst the Indians, is very remarkable. Poeppig, writing in 1830, says that in the Peruvian province of Huanuco the people, who are much subject to tertian agues, have a strong repugnance to its use. The Indian thinks that the cold north alone permits the use of fever-bark; he considers it as very heating, and therefore an unfit remedy in complaints which he believes to arise from inflammation of the blood.* Humboldt also notices this repugnance to using the bark amongst the natives; and Dr. Spruce makes the same observation with respect to the people of Ecuador and Colombia.† He says that they refer all diseases to the influence of either heat or cold; and, confounding cause and effect, they suppose all fevers to proceed from heat. They justly believe bark to be very heating, and hence their prejudice against its use in fevers, which they treat with *frescos* or cooling drinks. Even in Guayaquil the prejudice against quinine used to be so strong that, when a physician administered it, he was obliged to call it by another name.

* Poeppig, *Reise.*

† Dr. Spruce's Report.

CHAPTER III.

THE COUNTESS OF CHINCHON.

In 1638 the wife of Don Luis Geronimo Fernandez de Cabrera Bobadilla y Mendoza, fourth Count of Chinchon, and Viceroy of Peru, lay sick of an intermittent fever in the palace of Lima.*

This lady's maiden name was Ana de Osorio, a daughter of the noble family, whose founder was created Marquis of Astorga by Henry IV., King of Castille. The eighth Marquis had a daugher by his wife Doña Blanca Manrique y Aragon, named Ana, born in 1599, in her father's palace at Astorga.† Her father died on January 28th, 1613, and her mother at Valderas in 1619. Both are buried in the family chapel, in the cathedral of Astorga. Two years after her father's death the youthful Lady Ana, then only sixteen years of age, was taken from her home amidst

* In 1874, I published *A Memoir of the Lady Ana de Osorio, Countess of Chinchon and Vice-Queen of Peru.* (Trübner, 4to, pp. 99, with a map, pedigrees, and numerous illustrations.)

† Ford says: "A portion of the fine library of the palace at Astorga fortunately escaped Soult's camp fires, and now belongs to the Advocates at Edinburgh." Junot destroyed the old palace of the Osorios in April, 1810, and only two towers, with some armorial shields, remain.

the pleasant highlands of Leon—"a land of alpine passes, trout streams, verdant meadows, and groves of chesnuts and walnuts"*—to be married to Don Luis de Velasco, grandson of the first Marquis of Salinas, and the young couple went to live at Seville. But Don Luis died in the prime of life in 1619, and the Lady Ana, still young and very beautiful, became a widow and an orphan. She was made a lady-in-waiting to Queen Margaret, wife of Philip III., and removed from Seville to Madrid. Here she won the love of a nobleman of distinction. The youthful widow was married at Madrid, on Sunday, the 12th of August, 1621, to the Count of Chinchon. Her husband, of an old Catalonian family, was the grandchild of the first Count by Beatriz de Bobadilla, the faithful friend and attendant of Queen Isabella. He was hereditary Alcaide of Segovia, Lord of the Castle of Chinchon near Madrid, and of eighteen towns in the kingdom of Toledo.

The Count and Countess of Chinchon entertained Prince Charles and the Duke of Buckingham at the Alcazar of Segovia, when, says the record, "they supped on certain trouts of extraordinary greatnesse." In 1628 the Count was appointed Viceroy of Peru, and he and his Countess made their solemn entry into Lima on the 14th of January, 1629. The great event of this viceroyalty was the cure of the Countess of Chinchon, in the year 1638, of a tertian fever by the use of Peruvian bark. The news of her illness at Lima reached

* Ford.

Don Francisco Lopez de Cañizares, the Corregidor of Loxa, who had become acquainted with the febrifuge virtues of the bark. He sent a parcel of it to the Vice-Queen, and the new remedy, administered by her physician, Dr. Don Juan de Vega, effected a rapid and complete cure. It is known by tradition, amongst the bark collectors, that the particular species from which the bark was taken, which cured the Countess of Chinchon, was that known to them as *Cascarilla de Chahuarguera.** These trees are a variety of the *C. officinalis* of Linnæus, many thousands of which are now growing in India. There are four alkaloids with febrifuge virtues, in Chinchona bark, called quinine, quinidine, chinchonine, and chinchonidine. The *Cascarilla de Chahuarguera* abounds in chinchonidine, and Mr. Howard has pointed out that this particular alkaloid, concerning which there will be more to say in the sequel, probably cured the Countess.

Madame de Genlis wrote a short novel founded on the cure of the Countess of Chinchon, which she dedicated to the Comtesse de Choiseul. It is entitled *Zuma,*† and though erroneous in every particular so far as all the facts are concerned, it yet proves the deep and general interest which attaches to the first introduction of *quina* bark into Europe by the Vice-Queen.

* *Compendio Histórico-médico comercial de las Quinas*, por Don Hipolito Ruiz, MS. Quoted by Mr. Howard in his *Nueva Quinologia de Pavon.*

† Madame de Genlis' novel was translated into Spanish in 1827, and forms a little book entitled "*Zuma, ó el descubrimiento de la Quina, novelda Peruana.*"

The Countess of Chinchon returned to Spain in the spring of 1640, bringing with her a supply of that precious *quina* bark which had worked so wonderful a cure upon herself, and the healing virtues of which she intended to distribute amongst the sick on her husband's estates. It thus gradually became known in Europe, and was most appropriately called Countess's powder (*Pulvis Comitissæ*). By this name it was long known to druggists and in commerce. Dr. Juan de Vega, the learned physician* of the Countess of Chinchon, followed his patient to Spain, bringing with him a quantity of *quina* bark, which he sold at Seville for 100 reals the pound. The bark continued to have the same high value and the same reputation, until the trees became scarce and the collectors began to adulterate it.

After their return from Peru, the Count and Countess usually resided at the Castle of Chinchon, built by the Count's father in 1590. The Countess administered Peruvian bark to the sufferers from tertian agues on her lord's estates, in the fertile but unhealthy vegas of the Tagus, the Jarama, and the Tajuña. She thus spread blessings around her, and her good deeds are even now remembered by the people of Chinchon and Colmenar, in local traditions.†

* Dr. Juan de Vega, while at Lima, published a grammar of the language of the Peruvian Indians, entitled, "*Arte e Rudimentos de Gramática Quichua.*" (Impreso en Lima, 1636.)

† The Count of Chinchon was succeeded by his son, who was followed by two sons; here the male line ended. Their cousin, Francesca de Castro, then succeeded, and with her the family came to an end. Charles III. then granted the title of Count of Chinchon to his brother,

The town of Chinchon is in the south-east corner of the province of Madrid, on high ground, with hills, covered with wheat fields and vineyards, sloping off on one side to the *vega* of the Tagus, and on the other to that of the Tajuña. The distance from Madrid to Chinchon is twenty-four miles, and the ruins of the old castle, on its breezy hill, are seen from afar, with the little town nestling at its feet.

In memory of the great service to humanity performed by the Countess of Chinchon, Linnæus named the genus which yields Peruvian bark, *Chinchona*. Unfortunately the great botanist was misinformed as to the name of her whom he desired to honour. This is to be accounted for by his having received his knowledge of the Countess through a foreign, and not a Spanish source. Thus misled, Linnæus spelt the word *Cinchona* (Gen. Pl. ed. 1742) and *Cinhona* (Gen. Pl. ed. 1767), omitting one or two letters. It was still more unlucky that Linnæus died before the error was pointed out and corrected. This was done by the Spanish botanists Ruiz and Pavon, who landed in Peru in 1778, the year of Linnæus's death. They advocated the correct spelling of the name, and their example was followed by Mutis and others. The correct spelling ought now to be

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the Infante Don Luis. His illegitimate daughter was allowed to inherit it, and she conveyed it to her husband, Manuel Godoy, the Prince of Peace. Their daughter married the Duke of Alcudia, by whom she left a son, the present Count of Chinchon and Duke of Alcudia. He resides in Italy, but is lord of the estates of Chinchon and Villaviciosa.

generally adopted, because the mutilation of the name frustrates the object of Linnæus, which was to preserve the memory of the Countess. The genus is called *Chinchona* because it is named after the Countess of Chinchon.

CHAPTER IV.

INTRODUCTION OF THE USE OF BARK INTO EUROPE.

AFTER the cure of the Countess of Chinchon the Jesuits were the great promoters of the introduction of bark into Europe. In 1670 these fathers sent parcels of the powdered bark to Rome, whence it was distributed to members of the fraternity throughout Europe, by Cardinal de Lugo, and used for the cure of agues with great success. Hence the name of "Jesuits' bark," and "Cardinal's bark;" and it was a ludicrous result of its patronage by the Jesuits that its use should have been for a long time opposed by Protestants, and favoured by Roman Catholics. In 1679 Louis XIV. bought the secret of preparing quinquina from Sir Robert Talbor, an English doctor, for 2000 louis-d'or, a large pension, and a title. From that time Peruvian bark seems to have been recognised as the most efficacious remedy for intermittent fevers. The second Lord Shaftesbury, who died in 1699, mentions, in one of his letters:—"Dr. Locke's and all our ingenious and able doctors' method of treating fevers with the Peruvian bark." He declares his belief that it is "the most innocent and effectual of all medicines;" but he also alludes to "the bugbear

the world makes of it, especially the tribe of inferior physicians."

There can be no doubt that a very strong prejudice was raised against it, which it took many years to conquer; and the controversies that arose on the subject, between learned doctors, were long and acrimonious. Dr. Colmenero, a professor of the university of Salamanca, wrote a work in which he declared that ninety sudden deaths had been caused by its use in Madrid alone.* Chiflet (Paris, 1653) and Plempius (Rome, 1656), two great enemies of novelty, prophesied the early death of quinquina, and its inevitable malediction by future ages; while the more enlightened Badius (Genoa, 1656) defended its use, and quoted more than 12,000 cures by the aid of this remedy, performed by the best doctors of the hospitals in Italy. In 1692 Dr. Morton, one of the opponents of its use, was obliged to retract all he had said against quinquina; and it was then that it began to be generally admitted as a valuable medicine. It still, however, remained a subject of controversy, and as late as 1714 two Italian physicians, Ramazzini and Torti,† held opposite views on the subject. Ramazzini wrote against its use with much violence,‡ while Torti maintained that, in proper doses, it would arrest remittent and intermittent fevers.§

* Disertacion por Dr. Don Hipolito Unanue.

† Torti's work, *De Febribus*, was published at Venice in 1732.

‡ *Bernardini Ramazzini, Carpensis Philosophi ac Medici, opera omnia medica et physiologica.* (3rd edit., Londini, 1718, p. 123.) *De abusu Chinæ Chinæ dissertatio epistolaris.*

§ *Traité thérapeutique du Quinquina*, par P. Briquet. Paris, 1856.

Whilst the inestimable value of Peruvian bark was gradually forcing conviction on the most bigoted medical conservatives of Europe, and whilst the number and efficacy of the cures effected by its means were bringing it into general use, and consequently increasing the demand, it was long before any knowledge was obtained of the tree from which it was taken. In 1682 La Fontaine, at the solicitation of the Duchess of Bouillon, who had been cured of a dangerous fever by taking Peruvian bark, composed a poem in two cantos to celebrate its virtues;* but the exquisite beauty of the leaves, and the delicious fragrance of the flowers of the quinquina-tree, with allusions to which he might have adorned his poem, were still unknown in Europe.

* *Poëme du Quinquina et autres ouvrages, en vers.* Jean de la Fontaine. (Paris, 1682. 12mo. pp. 242.)

CHAPTER V.

DISCOVERY OF THE CHINCHONA TREES.

THEIR HABITAT AND CLASSIFICATION.

THE first description of the quinquina-tree is due to that memorable French expedition to South America, to which all branches of science owe so much. Its members, MM. De la Condamine, Godin, Bouguer, and the botanist Joseph de Jussieu, sailed from Rochelle on the 16th of May, 1735, to measure an arc of the meridian near Quito, and thus determine the shape of the earth. After a residence at Quito, Jussieu set out for Loxa, to examine the quinquina-tree, in March 1739, and in 1743 La Condamine visited Loxa, and stayed for some time at Malacotas, with a Spaniard whose chief source of income was the collection of bark. He obtained some young plants with the intention of taking them down the river Amazons to Cayenne, and thence transporting them to the Jardin des Plantes at Paris; but a wave washed over his little vessel near Para, at the mouth of the great river, and carried off the box in which he had preserved those plants for more than eight months. "Thus," he says, "I lost them after all the care I had taken during a voyage of

more than twelve hundred leagues." * This was the first attempt to transport chinchona plants from their native forests.

Condamine described the quinquina-tree of Loxa in the '*Mémoires de l'Académie;*' † he was the first man of science who examined and described this important plant; and in 1742 Linnæus established the genus CHINCHONA,‡ in honour of the Countess Ana of Chinchon. He, however, only knew of two species, that of Loxa, which was named *C. officinalis*,§ and the *C. Caribœa*, since degraded to the medicinally worthless genus of *Exostemmas*.

Joseph de Jussieu, whose name is associated with that of La Condamine in the first examination of the chinchona-trees at Loxa, continued his researches in South America after the departure of his companion. He penetrated on foot into the province of Canelos, the scene of Gonzalo Pizarro's wonderful achievements and terrible sufferings; ‖ he visited Lima with M. Godin; he travelled over Upper Peru as far as the forests of Santa Cruz de la Sierra; and he was the first botanist who examined and sent home specimens of the coca plant, the beloved narcotic of the Peruvian Indian. After fifteen years of laborious work he was robbed of his large collection of plants by a servant at Buenos

* *Voyage de Condamine*, p. 31. † 1738, p. 226.

‡ In the second edition of his *Genera Plantarum*.

§ So named by Linnæus, in 1753, in the first edition of his *Species Plantarum*, also in 1759, in his second edition.

‖ See my translation of the narrative of the memorable expedition of Gonzalo Pizarro, in the volume entitled *The Valley of the Amazons*, forming one of the Hakluyt Society's series.

Ayres, who believed that the boxes contained money. This loss had a disastrous effect on poor Jussieu, who, in 1771, returned to France, deprived of reason, after an absence of thirty-four years. Dr. Weddell has named the shrubby variety of *C. Calisaya* in honour of this unfortunate botanist, *C. Josephiana*.

For many years the quinquina-tree of Loxa, the *C. officinalis* of Linnæus, was the only species with which botanists were acquainted; and from 1640 to 1776 no other bark was met with in commerce than that which was exported from the Peruvian port of Payta, brought down from the forests in the neighbourhood of Loxa. The constant practice of improvidently felling the trees over so small an area for more than a century, without any cessation, inevitably led to their becoming very scarce, and threatened their eventual extinction. As early as 1735 Ulloa reported to the Spanish Government, that the habit of cutting down the trees in the forests of Loxa, and afterwards barking them, without taking the precaution of planting others in their places, would undoubtedly cause their complete extirpation. "Though the trees are numerous," he added, "yet they have an end;" and he suggested that the Corregidor of Loxa should be directed to appoint an overseer, whose duty it should be to examine the forests, and satisfy himself that a tree was planted in place of every one that was felled, on pain of a fine.* This wise rule was never enforced, and sixty years afterwards Humboldt reported that 25,000 trees were destroyed in

* *Noticias Secretas*, p. 572.

one year. Yet the Jesuits are said to have enforced it as a religious duty that, for every tree felled, the bark collector should plant a quincunx.

The measures adopted by the Spanish Government towards the end of the last century, in sending botanical expeditions to explore the chinchona forests in other parts of their vast South American possessions, led to the discovery of additional valuable species, the introduction of their barks into commerce, and the reduction of the pressure on the Loxa forests, which were thus relieved from being the sole source whence Peruvian bark could be supplied to the world.

The region of chinchona-trees extends from 19° S. latitude, where Weddell found the *C. australis*, to 10° N., following the almost semicircular curve of the cordillera of the Andes over at least 1500 miles of latitude. They flourish in a cool and equable temperature, on the slopes and in the valleys and ravines of the mountains, surrounded by the most majestic scenery, never descending below an elevation of 2500, and ascending as high as 9000 feet above the sea. Within these limits their usual companions are tree-ferns, Melastomaceæ, arborescent passion-flowers, and allied genera of chinchonaceous plants. Below them are the forests abounding in palms and bamboos, above their highest limits are a few lowly Alpine shrubs. But within this wide zone grow many species of chinchonæ, each within its own narrower belt as regards elevation above the sea, some yielding the inestimable bark, and others commercially worthless. And the species of chinchonæ, in

their native forests, are not only divided from each other by zones as regards height above the sea, but also by parallels of latitude. In Bolivia and Caravaya, for instance, the valuable *C. Calisaya* abounds, but it is never found nearer the equator than 12° S. Between that parallel and 10° S. the forests are for the most part occupied by worthless species, while in Northern Peru the grey barks of commerce are found. In each of these latitudinal regions the different species are again divided by belts of altitude. Yet this confinement within zones of latitude and altitude is not a constant rule; for several of the hardier and stronger species have a wider range; while the more sensitive, and these are usually the most precious kinds, are close prisoners within their allotted zones, and never pass more than a hundred yards beyond them. All the species are, of course, affected by local circumstances, which more or less modify the positions of their zones, as regards altitude.

Thus, to give a geographical summary of the chinchona region, beginning from the south, it commences in the Bolivian province of Cochabamba in 19° S., passes through the yungus of La Paz, Larecaja, Caupolican, Coroico, and Munecas, into the Peruvian province of Caravaya; thence through the Peruvian forests, on the eastern slopes of the Andes, of Marcapata, Paucartampu, Santa Ana, Huanta, and Uchupampa, to Huanuco and Huamalies, where the grey bark is found. It then continues through Jaen, to the forests near Loxa and Cuenca, and on the western

slopes of Chimborazo. It begins again in latitude 1° 51′ N. at Almaguer, passes through the province of Popayan, and along the slopes of the Andes of Quindiu, until it reaches its extreme northern limit on the wooded heights of Merida and Santa Marta. From Coroico in Bolivia to Huanuco, the distance is 680 miles; from Huanuco to Loxa 500; from Loxa to Riobamba, where the red bark tree grows, 180 miles. The whole length of the chinchona region from Bolivia to the forests of Colombia is 1500 miles.

Humboldt remarks that, beyond these limits, the Silla de Caracas, and other mountains in the province of Cumana, possess a suitable altitude and climate for the growth of chinchona-trees, as well as some parts of Mexico, yet that they have never been found either in Cumana or Mexico; and he suggests that this may be accounted for by the breaks which take place in Venezuela on the one hand, and on the isthmus of Panama on the other, where tracts of country of low elevation intervene between the lofty mountains of Cumana and Mexico and the chinchona region of the main Andes. In these low districts the chinchona-trees may have encountered obstacles which prevented their propagation to the northward: otherwise we might expect to find them in the beautiful Mexican woods of Jalapa, whither the soil and climate, and their usual companions the tree-ferns and Melastomaceæ, would seem to invite them.*

* *Semanario de la Nueva Granada*, p. 283. I have since introduced chinchona cultivation into Mexico.

Be this how it may, the chinchona plant has never been found in any part of the world beyond the limits already described.

The chinchonas, when in good soil and under other favourable circumstances, become large forest trees; on higher elevations, and when crowded, and growing in rocky ground, they frequently run up to great heights without a branch; and at the upper limit of their zone they become mere shrubs. The leaves are of a great variety of shapes and sizes, but, in most of the finest species, they are lanceolate, with a shining surface of bright green, traversed by crimson veins, and petioles of the same colour. The flowers are very small, but hang in clustering panicles, like lilacs, generally of a deep roseate colour, paler near the stalk, dark crimson within the tube, with white curly hairs bordering the laciniæ of the corolla. The flowers of *C. micrantha* are entirely white. They send forth a delicious fragrance which scents the air in their vicinity.

The earliest botanists gave the name of Chinchona to a number of allied genera, which have since been separated, and grouped under other names.* There are three characteristics by which a chinchona may be known; the presence of curly hairs bordering the laciniæ of the corolla, the peculiar mode of dehiscence of the capsule from below upwards, and the little pits at the axils of the veins on the under sides of the

* Endlicher separated the species whose capsules begin to open from the top, and formed them into a subgenus, which he called *Cascarilla*. Klotzsch, combining these with other species characterised by a six-parted corolla, raised them to an independent genus called *Ladenbergia*.

leaves. These characters distinguish the chinchona from many trees which grow with it, and which might at first sight be taken for the same genus. The fact, established by the investigations of chemists, that none of these allied genera contain any of the medicinal alkaloids, has confirmed the propriety of their expulsion from the chinchona genus by botanists; and Dr. Weddell gives a list of seventy-three plants, once received as Chinchonæ, which are now more properly classed under allied genera, such as *Cosmibuena, Cascarilla, Exostemma, Remijia, Ladenbergia, Lasionema,* &c.*

Before the time of Dr. Weddell, the three best botanical works on the botany of the chinchona genus were the *Prodromus* of De Candolle, Endlicher's *Genera Plantarum,* and the essay by Klotzsch, published in Hayne's *Flore Médicale.*† In these works a well-defined distinction is drawn between the febrifuge and the pseudo-chinchona; by pointing out the distinguishing characteristics of the former as deduced from the dehiscence of the capsule, which is from the bottom to the top in true, and from the top to the bottom in false chinchonæ.‡

The number of species of Chinchonæ was at first established by Dr. Weddell at nineteen, and two doubtful; but the classification of this eminent authority, published in 1849, has since required much alteration and revision. For instance: Dr. Weddell gave no place to the "red-

* *Histoire naturelle des Quinquinas*, p. 72.

† *Darstellung und Beschreibung der in die Arzneikunde gebräuchlichen Gewächse.* (Berlin 1803–46.)

‡ But it has been observed by Dr. Karsten, and also by Mr. Howard, that this rule is not invariable.

bark" species, the richest in alkaloids, and one of the most important, which, through the investigations of Dr. Spruce, is now admitted by botanists as a distinct species, the *C. succirubra* (Pavon).

Dr. Weddell's list of 1849 is as follows: —

1. C. CALISAYA . .	(*Weddell*) . . .	Bolivia and Caravaya.
2. C. CONDAMINEA .	(*Humboldt*) . .	Loxa.
3. C. SCROBICULATA .	(*Humboldt*) . .	Peru.
4. C. AMYGDALIFOLIA	(*Weddell*) . . .	Peru and Bolivia.
5. C. NITIDA . . .	(*Ruiz and Pavon*)	N. Peru.
6. C. AUSTRALIS . .	(*Weddell*) . . .	Southern Bolivia.
7. C. BOLIVIANA . .	(*Weddell*) . . .	Caravaya and Bolivia.
8. C. MICRANTHA . .	(*Ruiz and Pavon*)	Peru and Bolivia.
9. C. PUBESCENS . .	(*Vahl*)	Peru and Bolivia.
10. C. CORDIFOLIA . .	(*Mutis*) . . .	New Granada.
11. C. PURPURASCENS .	(*Weddell*) . . .	Bolivia.
12. C. OVATA . . .	(*Ruiz and Pavon*)	Peru and Bolivia.
13. C. CHOMELIANA .	(*Weddell*) . . .	Bolivia.
14. C GLANDULIFERA .	(*Ruiz and Pavon*)	N. Peru.
15. C. ASPEaIFOLIA .	(*Weddell*) . . .	Bolivia.
16. C. HUMBOLDTIANA	(*Lambert*) . . .	Jaen.
17. C. CABABAYENSIS .	(*Weddell*) . . .	Caravaya.
18. C. MUTISII. . .	(*Lambert*) . . .	Loxa.
19. C. HIRSUTA . .	(*Ruiz and Pavon*)	N. Peru.

Doubtful.

C. DISCOLOR . .	(*Klotzsch*) . . .	N. Peru.
C. PALALBA . .	(*Pavon*) . . .	Peru.

In his notes on the Quinquinas,* dated 1870, Dr. Weddell published a revised scheme of the chinchona genus as follows :—

CHINCHONA I. *Stirps* C. officinalis :—
Ramus A. Euoffoinales. C. officinalis, var. *α*, Uritusinga.
„ *β*, Condaminea.
„ *γ*, Bonplandiana crispa.

* I printed a translation of Dr. Weddell's *Notes on the Quinquinas* in 1871, extracted from the *Annales des Sciences Naturelles*, 5th series, vols. xi. and xii.

Ramus B. Macrocalycinæ. C. macrocalyx, C. Palton.
C. suberosa.
C. coccinea.
C. heterophylla.
C. lucumæfolia, C. stupea.
C. lanceolata.
Ramus C. Lancifoliæ. C. lancifolia.
C. Forbesiana.
C. amygdalifolia.

CHINCHONA II. *Stirps* C. rugosæ :—
Ramus A. Eurugosæ. C. Pitayensis, α, colorata.
β, Trianæ.
γ, pallida.
δ, Almaguerensis.
C. corymbosa.
C. rugosa, β, crispa.
C. Mutisii.
C. hirsuta.
Ramus B. Pahudianæ. C. Caravayensis.
C. Pahudiana.
C. asperifolia.
C. umbellulifera.
C. glandulifera.
C. Humboldtiana.

CHINCHONA III. *Stirps* C. micranthæ :—
Ramus A. Scrobiculatæ. C. australis.
C. scrobiculata.
C. Peruviana.
C. nitida.
Ramus B. Eumicranthæ. C. micrantha, var. α, Huanucensis.
„ β, Reicheliana.
„ γ, affinis.
„ δ, Calisayoides.
„ ε, rotundifolia.

CHINCHONA IV. *Stirps* C. Calisayæ :—
C. Calisaya, var. α, vera.
„ β, microcarpa.
„ γ, Boliviana.
„ δ, oblongifolia.
„ ε, pallida.
C. Josephiana.
C. elliptica.

CHINCHONA V. *Stirps* C. ovatæ:—

Ramus A. Succirubræ.	C. purpurea.
	C. rufinervis.
	C. succirubra.
	C. erythroderma.
	C. rosulenta.
	C. erythrantha.
Ramus B. Euovatæ.	C. ovata, var. *α*, genuina.
	„ *β*, vulgaris.
	„ *γ*, pallescens.
	C. palalba.
Ramus C. Cordifoliæ.	C. cordifolia.
	C. lutea.
	C. platyphylla.
	C. subcordata.
	C. rotundifolia.
	C. Tucujensis.
	C. pubescens.
	C. Pelletieriana.
	C. obovata.
	C. purpurascens.
	C. decurrentifolia.
	C. Chomeliana.
	C. Barbacoensis.

This classification, however, will be altered as our knowledge increases, and indeed it already requires revision.

The commercially valuable species comprise but a small proportion of the whole; and as all these have been introduced into India, they need our special attention. They are as follows:—

I. *C. officinalis*, var. *α*, *Condaminea*
„ *β*, *Bonplandiana*
„ *γ*, *crispa*
} yielding crown bark.

II. *C. succirubra* (Pavon) yielding red bark.

III. *C. Pitayensis*, &c.
C. lancifolia
C. cordifolia
} „ Colombian bark.

IV. { *C. nitida* / *C. micrantha* / *C. Peruviana* } yielding grey bark.

V. *C. Calisaya* „ yellow bark.

These species yield medicinal barks, which are collected from five different regions in South America; and in the following chapter I propose to give a brief account of each of these regions, of their chinchona-trees, and of the investigations of botanists down to the time when measures were taken to introduce these inestimable plants into Java and India. Such an account will naturally divide itself into five sections:—

I.—The Loxa region, and its *crown barks.*
II.—The *red-bark* region, on the western slopes of Chimborazo.
III.—The Colombian region.
IV.—The Huanuco region in Northern Peru, and its *grey barks.*
V.—The *Calisaya* region, in Bolivia and Southern Peru.

Before entering on this subject, however, it will be well to cast a hasty glance at the progress of those investigations which ended in the discovery of the febrifuge principle in Peruvian bark.

CHAPTER VI.

THE BARK AND ITS FEBRIFUGE ALKALOIDS.

THE roots, flowers, and capsules of the chinchona-tree have a bitter taste with tonic properties, but the upper bark is the only part which is commercially valuable. M. Delondre decided that the fruit and flowers, though having a bitter principle, do not contain the alkaloids, while the roots contain them, though in smaller proportion than the bark of the trunk and branches. The bark of trees is composed of four layers—the epiderm, the periderm, the cellular layer, and the liber or fibrous layer, composed of hexagonal cells filled with resinous matter and woody tissue. In growing, the tree pushes out the bark, and as the exterior part ceases to grow, it separates into layers, and forms the dead part or periderm; which in chinchonas is partially destroyed, and blended with the thallus of lichens. The bark is thus formed of the dead part, or periderm, and the living part, or derm. On young branches there is no dead part, the exterior layers remaining entire, while the inner layers have not had time to develop. In thick old branches, on the contrary, the periderm or dead part is considerable, while the fibrous layer of the derm is fully developed. In preparing

the bark the periderm is removed by striking the trunk with a mallet, and the derm is then taken off by uniform incisions. The thin pieces from small branches are simply exposed to the sun's rays, and assume the form of hollow cylinders, or quills, called by the natives *canuto* bark. The solid trunk bark is called *tabla* or *plancha*, and, until recently, was sewn up in coarse canvas and an outer envelope of fresh hide, forming the packages called *serons*.*

The character of the transverse fracture affords an important criterion of the quality of the bark. Cellular tissue breaks with a short and smooth fracture, woody tissue with a fibrous fracture, as is the case with the *Calisaya* bark. The best characteristics by which barks containing much quinine may be distinguished are the shortness of the fibres which cover the transverse fracture, and the facility with which they may be detached, instead of being flexible and adhering as in bad barks. Thus, when dry *Calisaya* bark is handled, a quantity of little prickles run into the skin, and this forms one of its distinguishing marks.†

Until the present century Peruvian bark was used in its crude state, and numerous attempts were made at different times to discover the actual healing principle in the bark, before success was finally attained. The first trial which is worthy of attention was made in 1779 by the chemists Buguet and Cornette, who

* The *serons* of hide contained 150 lbs. of bark. But for the last two or three years the hide serons have been superseded by bales of 100 to 150 lbs. each.

† Weddell.

recognised the existence of an essential salt, a resinous and an earthy matter in quinquina bark. In 1790 Fourcroy discovered the existence of a colouring matter, afterwards called *chinchona red*, and a Swedish doctor named Westring, in 1800, believed that he had discovered the active principle in quinquina bark. In 1802 the French chemist Armand Seguin undertook the bark trade on a large scale, and found it necessary to study the means of discovering good barks, and distinguishing them from bad ones. He found that the best quinquina bark was precipitated by tannin, while the bad was not precipitated by that substance. In 1803 another chemist found a crystalline substance in the bark which he called "*sel essentiel fébrifuge*," but it was nothing more than the combination of lime with an acid which was named *quinic acid*. Reuss, a Russian chemist, in 1815, was the first to give a tolerable analysis of quinquina bark; and about the same time Dr. Duncan of Edinburgh suggested that a real substance existed as a febrifuge principle. Dr. Gomez, a surgeon in the Portuguese navy, in 1816, was the first to isolate this febrifuge principle hinted at by Dr. Duncan, and he called it *chinchonine*.*

But the final discovery of quinine is due to the French chemists Pelletier and Caventou, in 1820. They considered that a vegetable alkaloid, analogous to morphine and strychnine, existed in quinquina bark; and they afterwards discovered that the febrifuge principle was seated in two alkaloids, separate or to-

* Briquet, p. 22.

gether, in the different kinds of bark, called *quinine* and *chinchonine*, with the same virtues, which, however, were much more powerful in quinine. It was believed that in most barks chinchonine exists in the cellular layer, and quinine in the liber, or fibrous layer; but Mr. Howard has since shown that this view is quite incorrect.* In 1829 Pelletier discovered a third alkaloid, which he called *aricine*, of no use in medicine, and derived from a worthless species of chinchona, growing in most of the forests of Peru, called *C. pubescens*.†

The organic constituents of chinchona barks are—

Quina.	Quinovic acid.
Chinchonia.	Chinchona red.
Aricina.	A yellow colouring matter.
Quinidia.	A green fatty matter.
Chinchonidia.	Starch.
Quinic acid.	Gum.
Tannic acid.	Lignin.

These materials are in different proportions according to the barks. Grey bark chiefly contains chinchonine and tannin; Calisaya, or yellow bark, much quinine, and a little chinchonine; red bark holds a large percentage of chinchonidine; while the barks of Colombia chiefly contain quinine, chinchonidine and quinidine. The two latter alkaloids were definitively discovered in 1852 by M. Pasteur; although the Dutch chemist Heijningen had, in 1848, found what he called β quinine or quinidine.

* *Nueva Quinologia de Pavon*, No. 10.

† *Aricine*, as a sulphate, does not crystallise, but forms a peculiar trembling jelly. It was so named from the port of Arica, whence the bark of *C. pubescens* is exported.

Quinine is a white substance, without smell, bitter, fusible, crystallised, with the property of left-handed rotatory polarisation (lævogyrate). The salts of quinine are soluble in water, alcohol, and ether. Of all the salts the bisulphate of quinine is preferred, because it constitutes a stable salt, easy to prepare, and containing a strong proportion of the alkaloid. It is very bitter and soluble, and crystallises in long silky needles. It is prepared by adding sulphuric acid to the sulphate.*

Chinchonine differs from quinine in being less soluble in water, and being altogether insoluble in ether. It has the property of right-handed rotatory polarisation (dextrogyrate).

Quinidine also has the property of right-handed rotatory polarisation, and forms salts like those of quinine. It becomes green by successive additions of chlorine and ammonia.

Chinchonidine has not the property of turning green, and forms a sulphate almost exactly like sulphate of quinine† (lævogyrate).

The discovery of the alkaloids in the quinquina‡

* Pereira says that, if a substance suspected to contain *quina* be powdered, then shaken with ether, and afterwards successively treated with chlorine and ammonia, the liquid will assume a green colour if the slightest trace of quina be present.—*Mat. Med.* ii. part ii. p. 119. One or two pounds of bark suffice well for an analysis.

† *Traité thérapeutique du Quinquina et de ses préparations*, par P. Briquet. Paris, 1855. Also Pereira's *Materia Medica.*

‡ The word *quinquina* is generally adopted for the medical preparations which are taken from Peruvian bark. *Quina* signifies *bark* in Quichua, and *quinquina* is a bark possessing some medicinal property. *Quinine* is, of course, derived from *quina*, *chinchonine* from *chinchona*. The Spaniards corrupted the word *quina* into *china;* and in

bark, by enabling chemists to extract the healing principle, has greatly increased the usefulness of the drug. Chinchonidine and quinidine are quite equal to quinine as cures for fever, and chinchonine is only slightly less efficacious. It is equally a febrifuge, but must be taken in larger doses. Thus these alkaloids not only possess tonic properties to which recourse may be had under a multitude of circumstances, but also have febrifuge virtue which is unequalled, and which has rendered them almost a necessary of life in tropical countries and in low marshy situations where agues prevail. Many a poor fellow's life was saved in the Walcheren expedition by the timely arrival of a Yankee trader with some chests of bark, after the supply had entirely failed in the camp.* Dr. Baikie, in his voyage up the Niger, attributed the return of his men alive to the habitual use of quinine; and the number of men whose lives it has saved in our naval service and in India will give a notion of the vast importance of a sufficient and cheap supply of the precious bark which yields it. India and other countries have been vainly searched for a substitute for quinine, and we may say with as much truth now as Laubert did in 1820—"This medicine, the most precious of all those known in the art of healing, is one of the greatest conquests

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homœopathy the word *china* is still retained. In 1735, when M. de la Condamine visited Peru, the native namo of *quina-quina* was almost entirely replaced by the Spanish term *cascarilla*, which also means bark.

* *Autobiography of Sir James MacGrigor*, chap. xii. p. 241.

made by man over the vegetable kingdom. The treasures which Peru yields, and which the Spaniards sought and dug out of the bowels of the earth, are not to be compared for utility with the bark of the quinquina-tree, which they for a long time ignored.*

* *Dictionnaire des Sciences Médicales*, quoted by Delondre, p. 7.

CHAPTER VII.

THE VALUABLE SPECIES OF CHINCHONA-TREES—THEIR HISTORY, THEIR DISCOVERERS, AND THEIR FORESTS.

I.—THE LOXA REGION, AND ITS *CROWN BARKS.*

THE region around Loxa, on the southern frontier of the modern republic of Ecuador, is the original home of the Chinchona, and nearly in the centre of its latitudinal range of growth. On the lofty grass-covered slopes of the Andes, around the little town of Loxa, and in the sheltered ravines and dense forests, those precious trees were found which first made known to the world the healing virtues of Peruvian bark. They were most plentifully met with in the forests of Uritusinga, Rumisitana, Cajanuma, Boqueron, Villonaco, and Monje, all within short distances of Loxa.

Linnæus named these trees *Chinchona officinalis;* but when Humboldt and Bonpland examined them, the discovery of other species yielding medicinal bark induced them to rechristen this species after the distinguished Frenchman who had originally described them, *Chinchona Condaminea.* Sir J. Hooker has since restored the old name of Linnæus, and the species is now known as *C. officinalis.* Humboldt says that they

grow on mica slate and gneiss, from 6000 to 8000 feet above the sea, with a mean temperature between 60° and 65° Fahr. In his time the tree was cut down in its first flowering season, or in the fourth or seventh of its age, according as it had sprung from a vigorous root-shoot, or from a seed. He describes the luxuriance of the vegetation to be such that the younger trees, only six inches in diameter, often attain from fifty-three to sixty-four English feet in height. "This beautiful tree," he continues, "which is adorned with leaves above five inches long and two broad, growing in dense forests, seems always to aspire to rise above its neighbours. As its upper branches wave to and fro in the wind, their red and shining foliage produces a strange and peculiar effect, recognisable from a great distance."* It varies much in the shape of the leaves, according to the altitude at which it grows, and bark-collectors themselves would be deceived if they did not know the tree by the glands, so long unobserved by botanists. The *C. Condaminea* described by Humboldt is the same as the *C. Uritusinga* of Pavon. It once yielded great quantities of thick trunk bark, but, owing to reckless felling through a course of years, it is now almost exterminated, and its bark is rarely met with in commerce. The distinguished botanist Don Francisco Caldas examined the chinchona forests of Loxa after Humboldt, between 1803 and 1809. He says that the famous quina-tree of Loxa grows in the forests of Uritusinga and Cajanuma, at a height of from 6200 to

* *Aspects*, ii. p. 267.

8200 feet above the sea, in a temperature of 41° to 72° Fahr.; but that it is only found between the rivers Zamora and Cachiyacu.* He describes the tree as from thirty to forty-eight feet high, with three or more stems growing from the same root; the leaves as lanceolate, shining on both sides, with veins a rosy colour, a short and tender pubescence on the under side when young, and when past maturity a bright scarlet colour; the bark black when exposed to the sun and wind, a brownish colour when closed in by other trees, and always covered with lichens;† and the rock on which the trees grow, a micaceous schist.

Don Francisco José de Caldas, a native of New Granada, was one of the most eminent scientific men that South America has yet produced. He was associated with Mutis in the botanical expedition of New Granada; he explored the chinchona region as far as Loxa; and thus takes his place as one of those to whom we are indebted for throwing light on the nature of the trees yielding Peruvian bark. Caldas was born at Popayan in the year 1770; and, from early youth, devoted himself to the pursuits of science with untiring energy, especially studying botany, mathematics, meteorology, and physical geography. He constructed his own barometer and sextant, and, ignorant of the methods adopted in Europe, he discovered the way of ascertaining altitudes by a boiling-point thermometer.

* *Semanario de la Nueva Granada.*

† From Martius: a note in No. 1 of Howard's *Nueva Quinologia de Pavon.*

He has left many memoirs on botanical and other subjects behind him, and his style is always animated, clear, and interesting; but many of the productions of this remarkable man are still in manuscript,* and others are lost to us for ever. Above all, it is to be regretted that his botanical chart of the chinchona genus, which he promised in one of his memoirs, has never seen the light.

The Spanish botanists Ruiz and Pavon also examined the chinchona-trees of Loxa; and the latter described two species, *C. Uritusinga*, named from the mountain on which it was once most abundant, and *C. Chahuarguera*, so called from a fancied resemblance of the bark to a pair of breeches (*huara* in Quichua) made from the fibre of the American aloe (*chahuar*). To these the botanist Tafalla added the *C. crispa*. These three species are all included in Humboldt's *C. Condaminea*, which is readily known by the little pits, bordered with hairs, at the axils of the veins on the under side of the leaf. It would appear that at one period of growth these little pits or scrobicules are wanting, but when the plant is in full vigour they are markedly prominent. The *C. Chahuarguera* † is described by Pavon as growing from eighteen to twenty-four feet in height; although now the trees, which yield the Loxa bark of commerce, do not attain a height of more than four to nine feet. It is met with on the

* Some of these MSS. are, I believe, in possession of Don Pedro Carbo, of Guayaquil.

† It is the form of *C. Condaminea*, represented in the unshaded branch with capsules, Plate x. of the *Plantes Æquinoctiales*.

grassy open crests of mountain ridges, in light sandy soil interspersed with rocks, amongst shrubs and young plants. The barks of Loxa were called *crown barks*, because they were reserved for the exclusive use of the royal pharmacy at Madrid; and they originally sold at Panama for five and six dollars, and at Seville for twelve dollars the pound; but in later times they were much adulterated, and the price fell to one dollar the pound.

The *C. Chahuarguera* is the *rusty crown bark* of commerce,* and the *C. crispa* is the *quina fina de Loxa* or *crespilla negra* of the natives. With this *rusty crown bark* are mixed larger quills particularly rich in the alkaloid called chinchonidine. The *C. Uritusinga* grew to the height of a lofty forest tree, but it is now nearly exterminated. The leaves assume a red colour before they fall, acquiring the most beautiful tints, and the tree is one of the finest in those forests.† It is said that there is a great difference in the bark, according as it is grown on the sides of mountains most exposed to the morning or evening sun; and its position is believed to have a great influence on the quality of its alkaloids. The usual yield of the large quills is 3·5 to 3·6 per cent.‡

The bark-collectors of Loxa are said to show some little forethought, a quality which is entirely wanting

* It comes in very small quills, as if taken from a mere shrub.

† I found some very beautiful dried specimens of this species in the botanical gardens at Madrid in 1862. The lanceolate leaves and panicles of flowers still retained their colour. They were marked "*Cascarilla fina de Uritusinga de Loxa, Quin. de Pavon.*"

‡ Howard's *Nueva Quinologia de Pavon.*

in most of their fraternity. To save the trees they occasionally cut off the whole of the bark, with the exception of one long strip, which gradually replaces its loss; and the second cutting is called *cascarilla resecada*. This practice was in use in the days of the botanist Ruiz, who protested against it, and declared that it was very injurious to the trees, many having been destroyed by it.* Later accounts, however, show that the bark-collectors of Loxa are as thoughtlessly destructive as those in other parts of South America. They often pull up the roots, while the annual burning of the slopes, and the continual cropping of the young shoots by cattle, assist the work of destruction.†

It is, therefore, well that the *C. Chahuarguera* and *C. Uritusinga*, the earliest known and among the most valuable of the chinchona-trees, should have been saved from extinction by timely introduction into India.

II.—THE "RED BARK" REGION, ON THE WESTERN SLOPES OF CHIMBORAZO.

The species yielding "red bark," the richest and most important of all the Chinchonæ, is found in the forests on the western slopes of Mount Chimborazo, along the banks of the rivers Chanchan, Chasuan, San Antonio, and their tributaries. So early as 1738 Condamine spoke of "red bark" (*cascarilla colorada*) as being of superior quality;‡ and Pavon sent home specimens of

* *Howard*, from MS. of Ruiz. † Mr. Cross's *Report*, Nov. 1861.
‡ Pereira, *Materia Medica*, ii. p. 106.

the "red bark of Huaranda," and named the species *C. succirubra.* Some of these specimens are now in the British Museum; and in the collection of Ruiz and Pavon, in the botanical gardens at Madrid, I found capsules, flowers, and leaves marked "*cascarilla colorada de los cerros de San Antonio.*" In 1857 Dr. Klotzsch, an eminent German botanist, read a paper at Berlin,* elaborately describing the "red bark" as a product of *C. succirubra,* from a very good specimen of Pavon's in the Berlin Museum. Mr. Howard also received a specimen from Alausi, and he was inclined to the belief that there are several varieties of *C. succirubra,* and one or two allied species, as yet undescribed.† Much light was thrown upon the history of this valuable species by Dr. Spruce, when he penetrated into the forests to collect seeds and plants for transmission to India in 1860.

Though little was known of the tree until quite lately, there was never any doubt concerning the value of the bark. In 1779 a Spanish ship from Lima, bound to Cadiz, was captured off Lisbon by the *Hussar* frigate, and her cargo consisted chiefly of "red bark," part of which was imported into England. In 1785 and 1786 Ruiz states that the collectors began to gather the bark of *C. succirubra,* and sell it at Guayaquil, and from that time it continued to be found in the European markets.

* Afterwards published in a pamphlet of fifty-seven pages, with plates.

† In 1856 Mr. Howard shared Dr. Weddell's belief that the "red bark" belonged to a variety of *C. ovata.*—*Pharmaceutical Journal,* Oct. 1856.

It contains a larger proportion of alkaloids than any other kind, chiefly chinchonidine. Mr. Howard has procured 8·5 per cent. of alkaloids from a specimen of "red bark" from South America. A large supply of plants of this species is flourishing in India and Ceylon, and it has become a cultivated plant of great value and importance, with a much greater yield of total alkaloids than when in its wild state.

III.—THE COLOMBIAN REGION.

The importance of the chinchona-trees was fully established in the middle of the last century, and Don Miguel de Santistevan, the director of the mint at Bogotá, having addressed a memorial on the bark trade (*estanco de cascarilla*) to the Viceroy Marquis of Villar, in 1753, the attention of the Spanish Government was seriously turned to the subject. Eight years afterwards the botanist Mutis landed in South America.

José Celestino Mutis was born at Cadiz on the 6th of April, 1732. His father was Don Julian Mutis, and his mother Doña Gregoria Bossio, the former a native of Ceuta, and the latter of Cadiz, where they were married in 1724. Young José Celestino took his bachelor's degree at the University of Seville in 1753, and afterwards practised medicine, receiving his diploma as physician at Madrid in 1757. While Mutis was at Madrid, Don Pedro Mesia de la Cerda, the newly appointed Viceroy of Nueva Granada, was looking out for a physician to accompany him on his long voyage to

South America. His choice fell upon Mutis, who sailed with him, and disembarked at Carthagena, in 1760. Mutis established himself at Bogotá, the capital of the Viceroyalty, and having devoted many years to the study of the plants of the cordilleras, he eventually obtained for himself a literary and scientific reputation throughout Europe, corresponding with Linnæus * and other eminent naturalists. He entered holy orders in 1772, and settled permanently in South America.

In 1783, King Charles III., by the advice of the Viceroy Don Antonio Caballero y Gongora, nominated Mutis to be director-in-chief of a botanical expedition in the new kingdom of Granada, which was intended to be the counterpart of that formed for Peru and Chile, in 1777, under Ruiz and Pavon. Mutis not only organised this new botanical expedition, but also instructed many South American youths in drawing plants and in the science of botany. He held the office of Botanical Director from 1783 until his death in 1808. For seven years he made his head-quarters at Mariquita, in the fertile valley near the river Mariquita, at the foot of the Andes of Quindiu. But in 1798, his health becoming affected by so long a residence in a tropical climate, he removed to Bogotá, and turned his attention to the collection of plants at high altitudes. Here, by order of the Viceroy, Marquis of Sonora, he formed an astronomical observatory, in 1802, and here he received and

* Linnæus modified his description of the chinchona genus in the 12th edition of his *Systema*, in consequence of information contained in a letter from Mutis, dated 1764.

entertained the great travellers Humboldt and Bonpland. Mutis died at Bogotá on September 2nd, 1808. His museum consisted of 24,000 dried plants, 5000 drawings of plants by his pupils, and a collection of woods, shells, resins, minerals, and skins. These treasures arrived safely at Madrid in 105 boxes, and the plants, manuscripts and drawings were sent to the botanical gardens, where they were buried in a tool-house.

The merits of Mutis with regard to the extension of our knowledge of the chinchona genus are undoubtedly great. He was one of the first labourers in that field of research, and he was a most indefatigable one. But he was engaged in somewhat heated controversies with other labourers in the same field. In 1772, in riding through the forest of Tena, about twenty miles from Bogotá, with his friend Don Pedro Ugarte, Mutis asserts that he first discovered the chinchona plant. But another resident in Bogotá, Don Sebastian José Lopez Ruiz, also laid claim to the discovery. This claimant said that, during a visit to Lima, he had been shown specimens of the plant yielding the bark of Loxa by the French botanist Jussieu; and that in travelling through Honda to Bogotá, he at once recognised the chinchona-trees, before Mutis ever came into the country. In 1776 he appears to have obtained a pension from the Viceroy, as a reward for his discovery, of which he was afterwards deprived, and he worked for some years under Government in the bark monopoly. In 1802 he published an indignant pamphlet on the subject of his wrongs, concluding with the following quotation: "*Has ego Chin-*

*chonas reperi, tulit alter honores."** Mutis and his disciples also had very hot arguments with the botanists Ruiz and Pavon, as to the respective merits of the chinchona species of New Granada and Peru.

The principal disciples of Mutis were Zea, Caldas, and the geographer Restrepo, all natives of Nueva Granada. Francisco Antonio Zea was born at Antioquia, and came, when very young, to Bogotá. Mutis sent him on a botanical excursion to Fusagasugá in 1793, and in 1795 he went to Spain, where he published a memorial on the chinchona genus, and entered into a hot argument with Ruiz and Pavon, as to whether the species in New Granada was the same as that of Loxa.† Francisco José de Caldas was born at Popayan in 1770, and was the most distinguished of the botanical disciples of Mutis. He was appointed a member of the botanical expedition in 1802. His journeys to the Loxa forests have already been noticed; and he also made large collections in the forests of Fusagasugá. He made some bitter complaints of the treatment he received from Mutis,‡ and of the absence of due recognition of his services. His end was melancholy. He joined the patriot cause, and was executed by order of the Spanish General Murillo on October 30th, 1816.

The work of Mutis on the chinchona genus is entitled

* *Defensa y demonstracion del verdadero descubridor de las quinas del Reyno de Santa Fé, con varias noticias útiles de este específico, en contestacion á la memoria de Don Francisco Antonio Zea. Su autor el mismo descubridor Don Sebastian Josef Lopez Ruiz.* (Madrid, 1802.)

† *Memoria sobre la quina segun los principios del Señor Mutis.* In the *Anales de Historia Natural de Madrid.* 1800, tom. ii. 196 et seq.

‡ *Semanario de la Nueva Granada*, p. 520.

El Arcano de la Quina, and is divided into four parts. It was sent to Madrid for publication in 1807,* but the French invasion stopped the work, and the manuscript was left among a heap of other books and papers. It accidentally fell into the hands of a Spanish physician, Don Manuel Hernandez de Gregorio, who published the first three parts, relating to the medicinal properties of bark, in 1828.† The fourth part remained in manuscript in a building in the botanical gardens at Madrid, together with a bundle of dried chinchona specimens, and some coloured drawings. I obtained a copy of it, which was printed in 1867, and the coloured drawings were afterwards reproduced at Paris, by Don José Triana. It seems that Mutis was not acquainted with the most valuable barks of Nueva Granada. His classification is as follows:—

C lancifolia (quina naranjada: tunita *vulgo*), 13 varieties.
C. cordifolia (quina amarilla), 5 varieties.
C. oblongifolia 3 varieties (*quina roja*) } not Chinchonæ, but
C. ovalifolia, 3 varieties (*quina blanca*) } Ladenbergias.
C. longiflora }
C. dissimliflora } not medicinal.
C. parviflora ‡ }

* Mutis commenced its publication in a periodical called *El Diario*, at Bogotá, in 1793–94 (No. 89, May 10, 1793, and No. 129, February 14, 1794), and an incomplete abstract of the first two parts afterwards appeared in the *Mercurio Peruano*, tom. xii. nos. 608, 609, 610, 611, pp. 211–46 (Lima, 1795). The article is headed *Observaciones y conocimientos de la Quina debidas al Doctor Don Celestino Mutis*, &c.

† *El Arcano de la Quina. Discurso que contiene la parte médica de las cuatro especies de Quinas oficinales, sus virtudes eminentes y su legítima preparacion. Obra póstuma de Doctor Don José Celestino Mutis.* (Madrid, 1828.)

‡ These are all figured, in coloured plates, in the work of Triana. (Paris, 1870.)

He erroneously identifies the barks of his own region with those of Loxa and Huanuco.

Dr. Karsten, an eminent German botanist, landed at Puerto Cabello in Venezuela, in the spring of 1844, and travelled in South America for twelve years. He found his first chinchona-trees on the southern declivity of the forest-covered mountains of Tovar, near Caraccas, at a height of 5500 feet above the sea. But it is necessary to remark that Dr. Karsten includes many species in his chinchona genus which would be excluded by Dr. Weddell, and those botanists who follow his system of classification. In 1852 Dr. Karsten reached Colombia, and met with the *C. lancifolia* (vulgo *tunita*) on the elevated table-lands north of Tunja. He also visited the home of another variety of the *C. lancifolia* of Mutis, called "*Calisaya de Santa Fé,*" which is near Popayan. I published Dr. Karsten's botanical descriptions, and reproduced some of his plates on a reduced scale, in 1867. Dr. Don José Triana has also studied the species of chinchona in his native Colombia; and he published the plates of Chinchonæ drawn under the superintendence of Mutis.*

The most important kinds of Colombian barks are,

* *Nouvelles études sur les Quinquinas d'après les matériaux présentés en* 1867 *à l'exposition universelle de Paris et accompagnées de fac-simile des dessins de la Quinologie de Mutis, suivies de remarques sur la culture des quinquinas par J. Triana* (folio, Paris, 1870).

Señor Triana says, in his introductory remarks:—"M. Markham, à qui l'art médical doit une si haute gratitude pour le zèle persévérant avec lequel il concourt à l'introduction des Chinchona dans l'Inde Orientale, a rendu récemment un nouveau service en publiant le texte du grand ouvrage de Mutis. Mais la reproduction des desseins de la *Quinologie* nous a paru indispensable à l'exacte et complète intelligence de ce

the *C. Pitayensis*, the plant yielding "*Calisaya de Santa Fé*," or soft Colombian bark, and that whence comes the Carthagena bark. All are now introduced into India.

IV.—THE HUANUCO REGION IN NORTHERN PERU, AND ITS GREY BARKS.

The chinchona-trees, in the forests of the province of Huanuco, in Northern Peru, were discovered by Don Francisco Renquifo in 1776, on the mountain of San Cristoval de Cuchero or Cocheros; and Don Manuel Alcarraz brought the first example of bark from Huanuco to Lima.

At almost the same time the Spanish Government was organising a botanical expedition to explore the chinchona forests of Peru; composed of the botanists Don José Pavon, Don Hipólito Ruiz, the Frenchman Dombey, and two artists named Brunete and Galvez. They embarked at Cadiz on November 4th, 1777, and reached Callao April 8th, 1778. Having made a large collection of plants in the neighbourhood of Lima, and despatched them to Spain,* they crossed the Andes, explored the forests of Tarma, and then proceeded to Huanuco. They traversed the valley of Chinchao, explored the hill of Cuchero or Cocheros, near Huanuco, and discovered

texte. Il nous a semblé, en outre, que nes études personnelles sur les *Chinchona* présentaient l'occasion de remplir cette lacune, et M. Markham a bien voulu répondre à notre appel et faciliter l'accomplissement de notre projet, en nous faisant obtenir du Ministère des Indes de sa Majesté Britannique une encourageante souscription."

* 300 dried specimens, and 242 coloured drawings, sent in the ship *Buen Consejo*.

seven species of chinchona-trees,* returning to Lima laden with the precious spoils of their expedition. They then sailed for Chile, and, after exploring the greater part of that province, they returned to Lima, and sent off their botanical collections in fifty-three boxes, which were all lost in the shipwreck of the *San Pedro de Alcantara*, off the coast of Portugal, in 1786. M. Dombey returned to Europe at about the same time.

Ruiz and Pavon then returned to Huanuco, explored the courses of the rivers Pozuzu and Huancabamba, and eventually established themselves at the farm of Macora, near Huanuco, where they resided for two months with Don Francisco Pulgar and Don Juan Tafalla, who, by order of the king, had joined them as pupils and associates in their labours—the first as an artist, the second as a botanist. In August, 1785, a fire broke out in their house, which destroyed all their journals and collections; and they then undertook journeys through the forests of Muña, Pillao, and Chacahuasi, examining new species of chinchonæ.† On April 1st, 1788, taking leave of Pulgar and Tafalla, they sailed from Callao,

* Namely:—

1. *C. lanceolata* . . . (*Cascarilla bobo amarillo*).
2. *C. purpurea* . . . (,, *de hoja morada*).
3. *C. ovata* . . . (,, *pata de gallareta*).
4. *C. nitida* . . . . (,, *fino*).
5. *C. hirsuta* . . . . (,, *fino delgado*).
6. *C. magnifolia* . . . (,, *flor de Azahar*). (,, *magnifolia*—Wedd.).
7. *C. glandulifera* . . . (,, *negrilla*).

† I have examined Pavon's dried specimens from Huanuco, now in the botanical gardens at Madrid.

There are leaves of *C. lanceolata*, from the forests of Muña; leaves

and reached Cadiz in September, when they commenced the publication of their great work the *Flora Peruviana.**

Tafalla continued his researches in the province of Huanuco, and discovered the *C. micrantha* in 1797, in the cool and shady forests of Monzon and Chicoplaya. Pavon calls him "noster alumnus."

The expeditions and discoveries of the Spanish botanists induced the merchants of Lima to speculate in bark, and brought the grey barks of Huanuco into the European markets.† In 1785 Don Juan de Bezares, a Lima merchant, devoted 2000 dollars to the exploration of the forests of Huamalies. He penetrated along the banks of the Monzon to Chicoplaya, passing mountains thickly covered with chinchona-trees, and engaged people to collect bark. Thousands of arrobas were thus obtained of the bark of *C. glandulifera;* and having been appointed Governor of Huamalies by the Viceroy Don Teodoro de Croix in 1788, Benzares commenced the construction of a good road down the valley of the Monzon.‡ Up to 1826 the principal supplies of grey bark were derived from *C. nitida*, but since that time they are believed to have come chiefly from *C. micrantha.*

and capsules of *C. ovata*, some of the former very slightly cordate, from Panao and Pillao; leaves, flowers, and capsules of *C. purpurea;* and leaves and capsules of *C. nitida*, from Cuchero.

* Ruiz published his *Quinologia* in 1792.

† At first, in the best years, as many as 25,000 arrobas of bark were exported from the province of Huanuco, and some large fortunes were made.—*Poeppig.* An arroba = 25 lbs.

‡ *Mercurio Peruano.*

Science owes much to the labours of Spanish botanists: the Spanish nation has every reason to be proud of her sons who explored the forests of the Andes with such un-

CHINCHONA MICRANTHA.

(From Howard's *Nueva Quinologia de Pavon.*)

tiring energy and distinguished ability; and the names of Mutis, Ruiz, Pavon, and Tafalla occupy no unimpor-

tant place in the history of botanical research. Nor, in this respect, have the natives of South America been behindhand. Caldas and Zea were worthy successors of Mutis; Franco Davila* represents the botanical learning of Peru; while in more modern times the name of the South American Triana is not unworthy to stand side by side with those of the best botanists in Europe.

After the days of Ruiz and Pavon, our chief authority on the grey barks of Huanuco is Dr. Poeppig, afterwards a professor in Leipzig, who travelled in Chile and Peru between the years 1827 and 1832.† He says that, as in New Granada, the grey barks of Huanuco soon fell into discredit in the European markets, owing to the adulterations of small speculators, and that after 1815 the trade almost entirely ceased.‡ In 1830 scarcely 1250 lbs. of bark found their way from Huanuco to Lima.

In the flourishing times of the Huanuco bark trade the *cascarilleros*, or bark-collectors, entered the forests in parties of ten or more, with supplies of food and tools. They penetrated for several days into the virgin forest until they came to the region of the chinchona-trees, where they built some rude huts and commenced their work. The *cateador*, or searcher, then climbed a high tree, and, with the aid of experience and sharp sight, soon discovered the *manchas* or clumps by their

* A Peruvian who was for many years Director of the Cabinet of Natural History in Madrid, during the reign of Charles III.

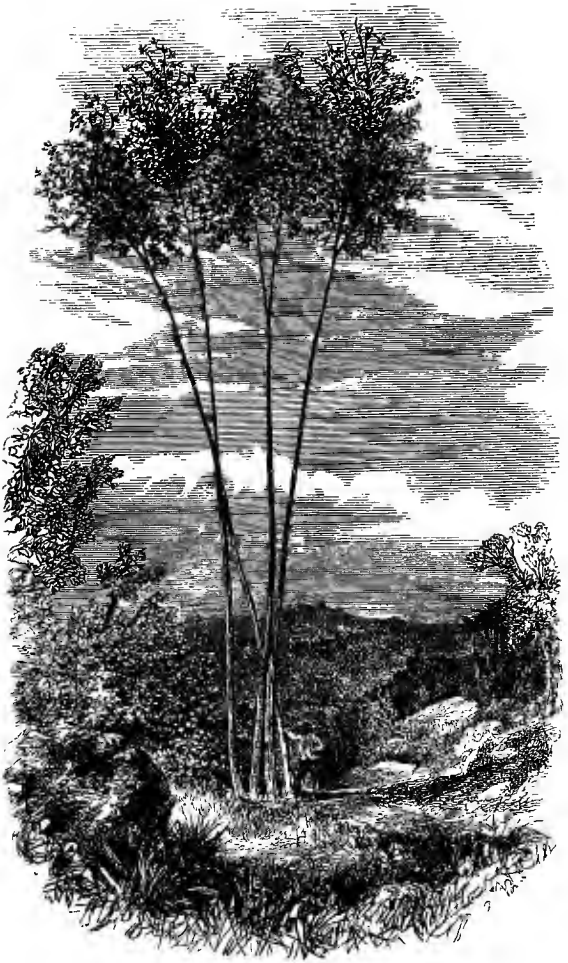
† *Reise in Peru, während der Jahre* 1827–32, von Eduard Poeppig, Professor an der Universität zu Leipzig, ii. pp. 217–23, 257–64.

‡ Stevenson, however, says that large quantities of bark were brought from the woods east of Huamalies in 1825.—*Travels*, ii. p. 66.

dark colour, and the peculiar reflection of the light from their leaves, easily observable even in the midst of these endless expanses of forest. The *cateador*, then, with never erring instinct, conducted the party for hours through the tangled brushwood, to the chinchona clump, using the wood-knife at every step. From a single clump they often obtained a thousand pounds of bark, which was sent up to be dried beyond the limits of the forest. All depended on the success of this operation, for the bark easily becomes mouldy and loses its colour. The *cascarilleros* got two rials for every twenty-five pounds of green bark stripped, from the speculator, and, as they could easily strip three hundred pounds, they made two dollars a day. The bark cost the speculator about four dollars, and the price at Lima was sixteen to twenty dollars the arroba of twenty-five pounds.*

Dr. Poeppig makes some important remarks on the supposed danger of the total extirpation of the chinchona-trees by reckless felling. Condamine and Ulloa believed that this would be the case in the Loxa forests, and Poeppig thinks that their apprehensions were well founded, because there the trees are not felled, but left standing deprived of their bark, in which case they are attacked by rot with extraordinary rapidity in tropical forests, hosts of insects penetrate to the stem, and the healthy roots become infected. But it is only necessary to observe the precaution of hewing the stem as near as possible to the root, in order to be sure of its after-

* Poeppig. Von Tschudi, p. 399.



CHINCHONA NITIDA TREES.

(From a sketch by Mr. Pritchett.)

growth. After six years, near Cuchero, the young stems may already be felled again; but, at higher altitudes, where the most effective chinchonas are found, it requires twenty years.*

The *C. micrantha* abounds in the province of Huanuco, and the bark is known as *Cascarilla provinciana.* It yields 2·7 per cent. of chinchonine, and used to be much sought after for the Russian market.

The *C. nitida* is a lofty tree growing in the higher regions of Huanuco, and is known by the natives as *quina cana legítima* (genuine grey bark). It grows at a greater height than the former species, and yields 2·2 per cent. of chinchonine.

The *C. Peruviana,* so named by Mr. Howard, is the *Cascarilla de pata de gallinazo* of the natives. It grows in the forests at a lower elevation than *C. nitida,* and yields 3 per cent. of chinchonine and chinchonidine, consequently indicating a considerable amount of febrifuge power. Quinine has also been found in samples of grey bark.†

The name of *grey* bark refers to the striking effect of the overspreading thallus of various *Graphideæ,* forming groups, and indicating that the tree has grown in an open situation, exposed to rain and sunshine. Plants of all the best kinds of grey bark are now growing in India.‡

* Poeppig. † Howard.

‡ I have caused the portion of Poeppig's work which relates to chinchona-trees to be translated and printed for use in India and Ceylon.

V.—THE CALISAYA REGION IN BOLIVIA AND SOUTHERN PERU.

The chinchona region of Bolivia and Southern Peru, although one of the most important, was the last to contribute supplies of bark to the European markets. The trees first became known through the investigations of the German botanist Thaddaeus Haenke, and a Spanish naval officer named Rubin de Celis, who drew the attention of the inhabitants to the valuable forests on the eastern slopes of the Bolivian Andes in 1776, though the unfortunate French naturalist Joseph de Jussieu had previously explored some portions of those forests.* But it was not until 1820, when quinine was first recognised as the febrifuge principle of bark, that the *Chinchona Calisaya* † was recognised as containing more of that alkaloid than any other species.

After 1820 the demand for *calisaya* bark increased enormously; great numbers of *cascarilleros*, or bark-collectors, entered the forests, and in a short time scarcely a tree remained in the vicinity of the inhabited places; and the bark was exported in such

* As early as 1790 the Calisaya bark was highly prized in Madrid.

† The valuable species found in Bolivia and Southern Peru. Dr. Weddell derives the name from the Quichua words *colli* (red) and *saya* (form); Poeppig, from *colla* (a remedy) and *salla* (rocky ground); Von Tschudi from *collisara* (reddish maize). Dr. Laefdael, the Judge of Caravaya, told me it came from *ccali* (strong) and *sayay* (become, or be thou). Calisaya is the name of a family of Indian Caciques in Caravaya, one of whom acted an important part in the revolt of 1780–1. The plant may have been called after him.

quantities that the price fell very much.* It was not, however, until 1830 that the Bolivian Government interfered in the bark trade. It was then considered necessary by General Santa Cruz's administration to check the drain of this precious source of wealth by limiting the quantity of bark to be cut or exported; and in November, 1834, the Bolivian Congress decreed a law on the subject, which, however, never took effect. Finally, the cutting was prohibited for five years, but before the expiration of that period the decree was abrogated, and an export duty of twelve dollars to twenty dollars the quintal, or cwt. was imposed.

In 1844 the Bolivian Congress authorised the President, General Ballivian, to negotiate for the establishment of a national bank of bark, with the requisite capital, to export all the quinquina bark produced in the country. This Bolivian legislation on the chinchona bark, which is considered, with justice, the most important product of their country, is very curious, and sufficiently demonstrates the futility of attempting a system of protection and monopoly. Instead of taking measures to prevent the reckless destruction of the trees, to establish extensive nurseries for young plants, and thus ensure a constant and sufficient supply of bark, these Bolivians have meddled with the trade, attempted to regulate European prices by the most barbarous legislation, and allowed the

* The bark of *C. Calisaya*, known as "yellow bark" in commerce, was at first erroneously believed to come from *C. cordifolia*, because Mutis had called the bark from that species *quina amarilla*, or "yellow bark." See p. 47.

forests to be denuded of chinchona-trees. In 1845 the bark monopoly was given to Messrs. Jorge Tesanos Pinto and Co., for five years, for the sum of 119,000 dollars, during which time not more than 4000 quintals of bark were to be exported annually. This company gave such iniquitously low prices to the *cascarilleros* for their bark, that a clamour was raised against it, and the President, General Belzu, put an end to its existence in March 1849.

Free trade, with a duty of twenty dollars the quintal, was then established during one year; but in 1850 exclusive privileges were again granted to Messrs. Aramayo Brothers and Co., who were to pay the Government 142,000 dollars a year for the right of exporting 7000 quintals of bark annually, to be purchased of the *cascarilleros,* the *tabla* or trunk bark at sixty dollars the quintal, and the *canuto* or quill bark at thirty to thirty-six dollars the quintal. The Pinto company had only paid eighteen to twenty-two dollars the quintal for *tabla,* and eight to ten dollars for *canuto* bark. The favourable conditions thus offered to *cascarilleros* induced so great a number of persons to undertake the business, that at the end of the first year more than 20,000 quintals of bark arrived at La Paz—that is to say, more than twice as much as the company had agreed for, and more than the Pinto company had exported in five years. The Government then issued a decree to prevent the smuggling of bark, and another that no bark should be cut except for the company: but these measures caused much discontent, and in 1851

the Congress voted that the Executive had exceeded its powers in making these arrangements with the Aramayo company, and declared them to be null and void. The Aramayo company purchased 14,000 quintals of the bark, and agreed to take the same quantity during the two following years, paying only a third of the price in ready money; but a new company, formed under the name of Pedro Blaye and Co., engaged to purchase all the bark that was for sale, both at La Paz and Cochabamba, for ready money. It was evident that one or the other of these companies must break, and finally that of Blaye fell. The Government then determined to export the bark which remained in store on its own account, paying the same price as had been agreed on by the company.

These two companies lasted for two years, during which time the Bolivian forests yielded 3,000,000 lbs. of bark. Such was the result of the high prices which followed the fall of the Pinto monopoly; but it was the rich contractors, and not the poor bark-collectors, who derived benefit from the change.*

In 1851 Government prohibited the cutting of bark entirely, from the 1st of January, 1852, to the 1st of January, 1854.† In 1858 a decree was issued to regulate the transition from the system of monopoly to that of free-trade in bark, which caused an improvement in the prices in European markets; and in

* This account of the Bolivian bark trade is from Dr. Weddell's *Voyage dans le Nord de Bolivie, et dans les parties voisines du Pérou.* Paris, 1853. Chap. xiii. p. 235.

† Gibbon's *Valley of the Amazon*, p. 147.

November, 1859, Dr. Linares, then President of Bolivia, declared the right to cut bark in the forests to be free and reduced the duty 25 per cent. on the current prices, to be fixed at the beginning of each year.* This is the law which regulates the bark trade in Bolivia, and, after a course of short-sighted meddling legislation, extending over twenty years, in 1850 it still brought 142,000 dollars annually into the public treasury, being a fifteenth part of the whole revenue of the Republic.

For exportation the bark used to be wrapped in fresh bullock-hides, having been previously sewn up in thick cotton bags containing 155 lbs. each. These hide packages are called *serons*, a mule-load being 285 lbs., and the transport to the coast costs about ten dollars for each mule-load. The bark from Bolivia now comes in bales.

It is to the persevering energy and great talent of that distinguished French botanist Dr. Weddell that we owe our knowledge of the chinchona regions of Bolivia and Southern Peru, and especially of the inestimable quinine-yielding species which he identified as the *C. Calisaya*. Dr. Weddell accompanied the scientific expedition of the Count de Castelnau, which was sent out by Louis Philippe to South America, and, after crossing the vast empire of Brazil, entered Bolivia by the country of the Chiquitos in August, 1845. It was Dr. Weddell's chief object to examine the chinchona region of this country, and his first step was to proceed to Tarija, to ascertain the extreme southern limit of the chinchona-trees, which he discovered in 19° S. lat. He

* *Mercurio del Vapor*, December 15, 1859.

named the species *C. australis*. Dr. Weddell then commenced a thorough exploration of the Bolivian chinchona forests, making his way over the most difficult country, from Cochabamba, through Ayopaya, Enquisivi, and the *yungus** of La Paz; where the species of chinchonæ continued to multiply under his eye. In Enquisivi he first met with and studied the *C. Calisaya*, which he named and described, collecting much information respecting the trade, and the methods of collecting bark. In 1847 he entered the province of Caupolican, descending the river Tipuani, where he was attacked by fever, and ascending the Mapiri. At Apollobamba, the centre of the most ancient bark-collecting district, he found that the surrounding forests were quite cleared of chinchona-trees, and that it was necessary to seek for them at a distance of ten or twelve days' journey from any inhabited place. In June 1847 Dr. Weddell entered the Peruvian province of Caravaya, examined the chinchona forests of the valleys of Sandia (San Juan del Oro) and Tambopata, and concluded his investigations by a visit to the lovely ravine of Santa Ana, near Cuzco.

Dr. Weddell was accompanied in his visit to the valleys of Santa Ana by M. Delondre, a manufacturer of quinine at Havre, who, after contemplating the project of paying a personal visit to the chinchona forests for twenty years, had at length set out, landed at Islay in July, 1847, and proceeded by way of Arequipa

* *Yuncu* is a tropical valley in Quichua, hence *yungus*, a Spanish corruption of the same word.

to Cuzco. M. Delondre appears to have employed a contractor to supply him with bark, who failed in his engagements, and of whom the French quinine manufacturer bitterly complains as a second Dousterswivel.* MM. Weddell and Delondre finally left the chinchona forests in September, 1847, and set out for the coast of Peru. Dr. Weddell's valuable monograph on the chinchona genus, *Histoire naturelle des Quinquinas*, the most important work that, up to that time, had appeared on the subject, was published at Paris in 1849.

In 1851 Dr. Weddell undertook a second voyage to South America, and in 1852 he entered the Bolivian chinchona region of Tipuani by way of Sorata. In descending the eastern slopes of the Andes he describes the vegetation as taking new forms at every mile of the descent. The undergrowth was formed of *Melastomaceæ* with violet-coloured flowers (*Chætogastra*), myrtles, *Gaultherias*, and *Andromedas;* lower down there were many superb species of *Thibaudias;* and, where the great forests succeed to the smaller growth of the more elevated region, the predominant trees were *Escallonias*, arborescent *Eupatorias*, *Bocconias*, and a fruit-bearing *Papilionacea* with a scarlet corolla. He encountered the first forest chinchona-trees at an elevation of 7138 feet, being the *C. ovata*, var. *a. vulgaris*. Descending still, he came to paccay-trees (*Mimosa Inga*) in flower, and met with the first plant of the shrubby variety of *C. Calisaya*, on an open grassy ridge or *pajonal*, at an elevation of 4800 feet.

* *Quinologie*, par M. A. Delondre. Paris, 1854.

Dr. Weddell descended the river Tipuani to Guanay, a mission of Lecos Indians, and ascended the Coroico in a canoe made of the wood of a species of *Bombax*. The forests bordering on the river Coroico abounded in many species of palms, chiefly *Maximilianas* and *Iriarteas*, the latter a singular kind with a trunk supported on long aerial roots. There were also many trees of *C. micrantha* on the banks of the Coroico, a species of chinchona, the peculiarity of which is its fondness for the bottoms of valleys and banks of rivers, while most of the others prefer elevated ridges or slopes of the mountains. With it were growing trees of the beautiful *Cascarilla magnifolia*, an allied genus with deliciously fragrant flowers.

The *cascarilleros* of Bolivia lead a hard and dangerous life. They only value the *C. Calisaya*, the other species being for them *carhua-carhua*, a name given to all the inferior kinds. Those who carry the bark on their shoulders from the interior of the forests receive fifteen dollars for every quintal, and they also have to carry all their provisions and covering for the night. If by any accident they are lost, or their provisions are destroyed, they die of hunger. Dr. Weddell, on one occasion, while ascending the Coroico, landed with the intention of passing the night on a beach well shaded by trees. Here he found the hut of a *cascarillero*, and near it a man stretched out on the ground in the agonies of death. He was nearly naked, and covered with myriads of insects, whose stings had hastened his end. His face was so swollen as to be wholly unrecognisable, and his

limbs were in a frightful state. On the leaves which formed the roof of the hut were the remains of this unfortunate man's clothes, a straw hat and some rags, with a knife, and an earthen pot containing the remains of his last meal, a little maize, and two or three *chuñus*. Such is the end to which their hazardous occupation exposes the bark-collectors—death in the midst of the forests, far from all friends—a death without help, and without consolation.

Dr. Weddell returned to La Paz by ascending the Coroico, and the results of his second visit to the chinchona forests appeared in an entertaining book of travels.* To this able botanist and intrepid explorer science is indebted, to no small extent, for the present state of our knowledge of the chinchona genus.

The *C. Calisaya* species has been divided by Dr. Weddell into two varieties, namely, *α vera*, and *β Josephiana*. The former, when growing under favourable circumstances, is a tall tree, often larger round than twice a man's girth, with its leafy head rising above all the other trees of the forest. The leaves are oblong or lanceolate-obovate, pitted in the axils of the veins, with a shining green surface, and reddish veins. The flowers, which hang in large panicles, are a rosy-white colour, with laciniæ rose-colour, and bordered by marginal white hairs. The capsule is smooth, and about twice as long as broad. This tree grows on declivities, and steep rugged places of the mountains, from 4900 to 5900 feet

* *Voyage dans le Nord de Bolivie, et dans les parties voisines de Pérou*, par H. A. Weddell. Paris, 1853.

above the sea, in the forests of Enquisivi, Caupolican, Apollobamba, and Larecaja in Bolivia, and of Caravaya in Peru. The trunk may be known by the periderm of the bark, sometimes of a greyish-white, sometimes brown or blackish, being always marked by longitudinal ridges or cracks, a characteristic remarked of no other tree of these forests, excepting one or two of the same family. The taste is strongly bitter, which is apparent directly the tip of the tongue touches it, and, when the exterior receives a cut, a yellow gummy resinous matter exudes from it. The bark comes off with great ease, like peeling a mushroom, while, in the inferior kinds, and above all in the false chinchonas, it strips transversely, and with much greater difficulty. A good tree yields 150 to 175 pounds of dried bark.

The other variety of *C. Calisaya*, called *ychu cascarilla*, or *cascarilla del pajonal*,* by the natives, was named *Josephiana* by Dr. Weddell after the unfortunate French botanist Joseph de Jussieu. It is a shrub, not attaining a greater height than six and a half to ten feet, and growing on open grassy slopes, at much higher elevations than the tree *Calisaya*. There is another tree variety with a somewhat darker leaf, which Dr. Weddell classed as a distinct species, and called *C. Boliviana* in 1849, but which he afterwards considered to be a mere variety of *C. Calisaya*. The other good kinds in the forests of Bolivia and Caravaya are *C. micrantha*, and two varieties of *C. ovata*.

* *Ychu* in Quichua, and *Pajonal* in Spanish mean the same thing, a pasture or grass-covered expanse.

Dr. Weddell brought seeds of *C. Calisaya* to Paris, which were raised in the Jardin des Plantes in 1848, and others in the garden of the Horticultural Society in London, where one of the plants flowered.* Many of these plants were given away, and some of them were sent by the Dutch Government to Java.

Plants of *C. Calisaya* are now flourishing in India. The average yield of quinine for the best kinds of South American *Calisaya* bark is 3·8 per cent., that for the *Josephiana* variety 3·29.† One variety grown in Java, from seeds transmitted by Mr. Ledger, yields nearly 10 per cent. of quinine.

* An account of it was published in the Journal of the Horticultural Society, vol. vii. p. 272.

† Pereira, *Mat. Med.* ii. part. ii. p. 118.

CHAPTER VIII.

RAPID DESTRUCTION OF CHINCHONA-TREES IN SOUTH AMERICA—IMPORTANCE OF THEIR INTRODUCTION INTO OTHER COUNTRIES—M. HASSKARL'S MISSION—CHINCHONA PLANTATIONS IN JAVA.

THE collection of bark in the South American forests was conducted from the first with reckless extravagance; no attempt worthy the name was made either with a view to the conservancy or cultivation of the chinchona trees; and both the complete abandonment of the forests to the mercy of every speculator, as in Peru, Ecuador and Colombia, and the meddling legislation of Bolivia, have led to equally destructive results. The bark-collector enters the forest and destroys the first clump of chinchona trees he finds, without a thought of any measure to preserve the continuance of a supply of bark. Thus, in Apollobamba, where the trees once grew thickly round the villages, no full-grown one is now to be found within eight or ten days' journey; * and so utterly improvident are the collectors that, in the forests of Cochabamba, they bark the tree without felling, and thus ensure its death; or, if they cut it down, they actually neglect to take off the bark on the

* Weddell, *Histoire Naturelle des Quinquinas.*

side touching the ground, to save themselves the trouble of turning the trunk over.*

A century ago Condamine† raised a warning voice against the destruction that was going on in the forests of Loxa. Ulloa‡ advised the Government to check it by legislation; soon afterwards Humboldt reported that 25,000 chinchona-trees were destroyed every year, and Ruiz§ protested against the custom of barking the trees, and leaving them to be destroyed by rot. But nothing was ever done in the way of conservancy, either by the Government, or by private speculators whose subsistence depended on a continued supply of bark. Dr. Weddell, alluding to this recklessness as regards *C. Calisaya*, observes that "the forests of Bolivia, rich as they are, cannot long resist the continual attacks to which they have been recently exposed. He who, in Europe, sees these enormous and ever-increasing masses of bark arrive, may perhaps believe that they will continue to do so; but he who sees the chinchona-trees in their native forests, and knows the real truth, is obliged to think otherwise."

There is, however, no danger of the actual extirpation of the trees unless the plan is adopted of leaving them standing, and stripped of their bark, as in the Loxa forests. Poeppig says that, in these cases, the trees in the tropical forests are attacked by rot with extra-

* Weddell, *Voyage dans le Nord de Bolivie.*

† *Mém. de l'Acad. Roy. des Sciences*, 1738, p. 226.

‡ *Noticias Secretas*, p. 572.

§ MS. quoted by Howard.

ordinary rapidity; hosts of insects penetrate the stem to complete the work of destruction, and the healthy root becomes infected. Thus the valuable species called *C. Uritusinga* has really been almost exterminated.

But where the trees are felled, it is only necessary to observe the precaution of hewing the stem as near as possible to the root, in order to be sure of its after-growth.* Under these circumstances, after six years the young trees are ready to be felled again in the milder regions, and after twenty years in cold and exposed localities. From the base of the stems, when not barked, a number of shoots spring out between bark and wood; and Dr. Karsten says that, though an interval of rest of twelve or fifteen years must be given to the forests where the chinchona-trees have thus been felled, this only promotes further investigation in the endless untrodden forests, while, in the meantime, the younger generation is growing up in those which have already been exhausted.†

The danger, therefore, is not in the actual annihilation of the chinchona-trees in South America, but lest, with the increasing demand, there should be long intervals of time during which the supply would cease, owing to the forests being exhausted, and requiring periods of rest. In many districts this is already the case. The bark which comes from Loxa is in the minutest quills, and in the forests of Caravaya, after an interval of rest of several years, the root-shoots had scarcely grown to a

* Poeppig. † Karsten.

sufficient size to yield anything but quill bark. Then again the supplies of bark from South America are not nearly sufficient to meet the demand, and the price is kept so high as to place this inestimable remedy beyond the means of millions of natives of fever-visited regions. For these reasons the incalculable importance of introducing the chinchona plant into other countries adapted for its growth, and thus escaping from entire dependence on the South American forests, has long occupied the attention of scientific men in Europe.

In 1839 Dr. Royle, in his *Illustrations of Himalayan Botany*,* recommended the introduction of the chinchona plants into India, pointing out the Nilgiri hills as a suitable site for the experiment, and Lord William Bentinck took some interest in the project. M. Fée had previously recommended the introduction of these plants into the French colonies;† and in 1849 both Dr. Weddell‡ and M. Delondre§ strongly urged the adoption of this measure. The former declared that posterity would bless those who should carry the idea into execution.‖

The Dutch, who possess in the island of Java a

* I. p. 245. Probably the idea was first conceived much earlier by Dr. Ainslie, who, half a century ago, remarked that it was matter of regret that "it had never been attempted to rear those articles of the Materia Medica in India, for which the world is now solely indebted to America."—Ainslie's *Materia Medica*, p. 66 (note).

† *Cours d'Hist. Nat. Pharm.* ii. p. 252.

‡ *Histoire Naturelle des Quinquinas*, p. 13.

§ *Quinologie*, par M. A. Delondre, p. 15.

‖ So convinced was Dr. Weddell that there was imminent danger of the supplies of bark eventually being exhausted, that he said, "Avant que le malheur que je prévois n'arrive (et ce ne sera pas de notre temps)

range of forest-covered mountains admirably adapted for chinchona cultivation, were, however, the first to take active steps for its introduction into the eastern hemisphere; and their praiseworthy exertions deserve, what they lay claim to with justice, the approbation of the whole civilised world.

For many years Dutch scientific men, among whom the name of the botanist Blume may be mentioned, had urged their Government to undertake the introduction of chinchona plants into Java. But it was not until the year 1852 that M. Pahud, the Dutch Minister of the Colonies, was authorised to employ an agent to collect plants and seeds of valuable species in Peru, and to convey them to Java. He selected, for this important mission, M. Justus Charles Hasskarl, a botanist who had for some time superintended the gardens in Java. Hasskarl sailed for Peru in December, 1852, with orders not to confine himself to the *Calisaya* plant, but to collect plants and seeds of as many different species as possible. His original orders were to proceed from Guayaquil to the chinchona forests of Loxa in the first instance; but he changed his plan, and landing at Lima, crossed the cordilleras in May, 1853.

It would be difficult, in making a chance journey from the coast to the forests of the Eastern Andes, to hit upon a part where valuable species of chinchona

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la science aura peut-être fait la conquête de quelque nouveau médicament qui rendra moins regrettable la perte de l'écorce de Pérou."—*Voyage dans le Nord de Bolivie*, p. 245.

trees are not known to exist. There are such spaces—forest tracts—intervening between the more favoured regions, where only species of little value are found, such as *C. pubescens, C. scrobiculata,* &c.; and one of these, between the region of grey barks in Huanuco and that of *C. Calisaya* in Caravaya, M. Hasskarl entered. He crossed the Andes by the road from Lima to Tarma, and descended the eastern slopes into the *montañas* of Vitoc, Uchubamba, and Monobamba; returning thence by Xauxa into the loftier region of the Andes. Near Uchubamba he saw trees which he believed to be *C. Calisaya;* but that species is never found to the north of the province of Caravaya. He however collected a quantity of seeds of a species which he called *C. ovata,* with smaller quantities of *C. pubescens* and *C. amygdalifolia.*

The species called by M. Hasskarl *C. ovata* at first formed the bulk of the chinchona plantations in Java. It was afterwards named *C. Pahudiana.* He found it on dry sunny hills, without much shelter from the sun, in a very sandy micaceous soil, at an elevation of 5500 to 6000 feet above the sea. It is sometimes a mere shrub, but occasionally rises to fifteen or twenty-five feet, with elegant pink flowers and reddish fruit. The native name is *cascarilla crespilla chica;* and as the *crespilla grande* is the *C. ovata* of Weddell, it is probable that M. Hasskarl was thus led into the mistake of calling his new species *C. ovata.* The leaves are smooth above, with a felt-like pubescence on the under surface, and the hairy capsules are probably

an indication of the worthlessness of the species.* In fact, no good kinds are found in this part of the country. He collected specimens of *C. lanceolata* of Pavon, at a place called "Escalera de San Rafael," on the road between Uchubamba and Xauxa.†

From Xauxa M. Hasskarl went to Cuzco, and thence in September to Sandia in the province of Caravaya; but finding that the seeds of chinchona-trees are ripe in August, and that he had arrived too late, he returned to Lima, and finally took up his abode at Arequipa until the following year. In March, 1854, he again set out, crossed the Andes to Puno, and, after wandering over part of Bolivia, at length reached the little village of Sina in Caravaya, near the frontier between Peru and Bolivia, in April. He had assumed the feigned name of José Carlos Müller, and had it printed on his cards, one of which he presented to the governor of Sina, Don Juan de la Cruz Gironda, requesting him to procure a supply of chinchona plants for him. Gironda refused, but introduced the stranger to a Bolivian named Clemente Henriquez, a clever and intelligent, but dishonest and unscrupulous man. Henriquez agreed to procure 400 plants of *C. Calisaya* for a certain sum, part of which was to be paid down, and the remainder on delivery of the plants. M. Hasskarl then went on to the village of Sandia, where he took up his abode, without entering the chinchona forests, and waited there until the plants should arrive. Meanwhile Henriquez employed an Indian to collect the stipulated number of

* Howard. † *Idem.*

plants, round a place called Ychu-corpa,* on the frontier of Bolivia; and when they were brought to him he went to Sandia, delivered them to M. Hasskarl, and received his money. An outcry was afterwards raised against Henriquez, by the people inhabiting villages bordering on the chinchona forests, who considered that their interests would be injured by the exportation of the plants: they declared they would cut his feet off if they caught him, and he has ever since been obliged to live at Pelechuco, in Bolivia.† This feeling rendered future operations of a like nature exceedingly difficult.

M. Hasskarl left Sandia with these plants in June, 1854, but they were not placed in Wardian cases at the port of Islay until August, and on the 27th of that month he finally left the coast of Peru in a sailing vessel, and shaped his course direct for Java.‡ He arrived at Batavia with twenty Wardian cases on December 13th, but all his plants afterwards died, except two.§ On his arrival M. Hasskarl was intrusted with the cultivation of chinchona plants in Java, with the rank of Assistant-Resident, and was made a Knight of the Netherlands Lion, and Commander of the Order of the Oaken Crown.‖

Besides the plants brought by M. Hasskarl, a plant of *C. Calisaya,* raised in Paris from seeds sent home

* *Ychu* is grass in Quichua, and *corpa* a lodging.

† Information from Gironda, then Governor of Sina.

‡ *Kew Miscellany*, Oct. and Nov. 1856.

§ Dr. Macpherson's Report, Dec. 19, 1860, No. 50, para. 8.

‖ *Bonplandia*, March, 1859, p. 72. The pay of an Assistant-Resident in Java is 500*l.* a-year.—Money's *Java.*

by Dr. Weddell, had arrived in Java; as well as plants raised from seeds previously sent from Peru, and seeds of *C. lancifolia* sent by Dr. Karsten from Colombia through the Governor of Curaçoa; and thus the experimental chinchona cultivation in Java was commenced.

M. Hasskarl deserves the greatest credit for the zeal and determination displayed by him in his journeys, during which he was surrounded by no ordinary amount of difficulties and dangers. He certainly proved himself to be a most indefatigable and courageous traveller.

M. Hasskarl, and his associate M. Teysmann, selected the site for the first chinchona plantation, at a place called Tjibodas, thirty miles south of Batavia, on the northern slope of the volcanic range which traverses Java from east to west, and 4400 feet above the sea. Ground was also prepared at Tjipannas, half a mile above Tjibodas, and 4700 feet above the sea. These sites were covered with rasamala trees of immense size (*Liquidambar Altingia,** Blume), which had to be felled. The superintendents, deceived by the sight of such large trees, imagined that the soil was deep and good, but in reality it was not more than six inches deep, and underneath there was a formation completely impenetrable to roots, called *tjadas*, composed of sand and small stones of trachytic origin, strongly cemented together by crater slime, the whole being as hard as

* A lofty tree, 150 to 200 feet high, with a very close-grained wood. It yields a fragrant resin called *storax*.

rock. Not one of the huge rasamala trees in reality pierced this *tjadas* with their roots, but ran along its surface horizontally for hundreds of feet. In these localities the chinchona plants continued to languish during 1855, and in the end of that year the experiment presented a most hopeless appearance.

The causes of this failure are sufficiently evident. After the felling of the rasamala-trees, the young chinchona plants were exposed to the full force of a burning sun, without any shade whatever, in an extraordinarily thin soil, upon a rocky bank impenetrable to roots. The dead and rotted roots of the rasamala-trees were allowed to remain, developing fungi which attacked the chinchona-roots ; and the sites themselves were in much too low and warm a climate. In consequence of the combined effects of these adverse influences, there were only 300 chinchona plants in Java, in a sickly unpromising condition, after the lapse of the first eighteen months.

In December, 1855, Dr. Franz Junghuhn came to Java with 139 chinchona plants, raised from seeds in Holland, but in six months seventy-six of them were dead. In June, 1856, M. Pahud, who had been Minister of the Colonies, and was then Governor-General of Netherlands India, relieved M. Hasskarl of his duties, and gave the entire charge of the chinchona experiment to Dr. Junghuhn, an experienced scientific botanist. Dr. J. E. de Vry, a chemist of great eminence, was also sent to Java, charged with the special duty of

applying chemical tests to the barks of the chinchona plants, to ascertain their intrinsic value.

When Dr. Junghuhn took charge, the prospects of the experiment were very far from promising, and he displayed an amount of intelligent perseverance, combined with much practical knowledge, which is deserving of all praise. He found the 139 chinchona plants which he himself brought out reduced to sixty-three; the seeds of *C. lancifolia* represented by three sickly plants; the collection of plants of *C. Calisaya* brought by M. Hasskarl from Peru, also reduced to three; two plants of *C. Calisaya* raised from seeds sent home by Dr. Weddell; and the remainder, consisting of the species collected by M. Hasskarl in Uchubamba, making a total of only 300 plants.

In 1856 a new system was introduced, an efficient establishment was formed, and a great effort was commenced to secure the successful cultivation of the chinchona plants. It was ordered that, until the cultivation was considered as quite successful, it should remain under the management of scientific men, but that finally it should be handed over to the ordinary direction of the chiefs of the provincial government, under the Director of Cultures; and a memorandum of instructions, consisting of eighteen articles, was drawn up for the guidance of Dr. Junghuhn and his subordinates.

Finding the chinchona plants in so deplorable a condition, one of Dr. Junghuhn's first measures was to transplant them from Tjibodas to a more suitable site

on the Malawar mountains, a very delicate and hazardous operation, which was, however, successfully performed: in 1857 plants both of *C. Calisaya* and of the worthless species blossomed, and in 1858 bore fruit. Dr. Junghuhn found that the latter could not be the *C. ovata* as named by M. Hasskarl; but he was himself equally mistaken in naming it *C. Lucumæfolia*, from a fancied resemblance to that species of Pavon. The great mistake of the Dutch has been in propagating this species, tempted by finding that its nature was hardy, and that it required less care than the delicate *C. Calisaya*.

Dr. Junghuhn established his new plantations on the slopes of the Malawar mountains, where he found that the *C. Calisaya* is much more sensitive than his so-called *C. Lucumæfolia*, now named *C. Pahudiana;* and that very slight differences in temperature, in elevation, in light, in shade, and in moisture, exercise a very evident influence on the former, while the latter remain quite unaffected by them. He considered that the best conditions for the growth of *C. Calisaya* on the Malawar mountains (between latitude 7° and 8° S.) were good loose forest soil and moderate shade, at an elevation from 5000 to 5700 feet above the sea. The *C. Calisayas*, when they receive light only on their crowns, and are surrounded by the dark wood, have a rapidly rising, slender, tall stem, devoid of side branches; whilst, when they stand on clear open spots, they grow much stronger in width and thickness, but are shorter, and have numerous side branches.

On the 31st of December, 1860, the number of chinchona plants in Java was as follows:—

C. Calisaya	7,316 plants and	1030 cuttings.
C. lancifolia	80 „ „	28 „
C. Pahudiana . . .	939,809 „ „	18 „
Total . . .	947,205 plants.	

Besides 700,264 seeds in stock, or sown. The extreme height attained by the tallest *C. Calisaya* was, at the same date, fifteen feet, and by the *C. Pahudiana* twenty-eight feet. One of the trees of *C. lancifolia* had also attained a height of fifteen feet.

Dr. de Vry, the eminent chemist who was associated with Dr. Junghuhn, and who had for two years previously occupied himself with the study of the chinchona alkaloids, was actively engaged in careful investigations of the chinchona barks in Java. With regard to the *C. Calisaya* his results were satisfactory. From the trunk-bark of a plant of this species, six years old, he obtained, in August, 1860, 5 per cent. of alkaloids; and from that of the branches, 2½ per cent. With the species introduced by M. Hasskarl, Dr. de Vry was not so successful. The leaves, flowers, fruit, and bark of this species were sent to Mr. Howard by Dr. Junghuhn; and it was found that the names of *C. ovata*, given it by M. Hasskarl, and of *C. Lucumæfolia* by Dr. Junghuhn, were equally erroneous. It was clear that it belonged to a species, not previously described, and Mr. Howard, in the seventh number of his work, has named it *C. Pahudiana*,* after M. Charles F. Pahud, who, as

* Howard's *Nueva Quinologia de Pavon.* No. 7.

Minister of the Colonies, sent M. Hasskarl to South America in 1852, and who, being appointed Governor-General of Netherlands India in 1855,* did so much to ensure the success of the chinchona experiment in Java. Up to 1860 Dr. de Vry only obtained 0·4 per cent. of alkaloids from the bark of *C. Pahudiana*, and Mr. Howard's examination coincided with the analysis of Dr. de Vry in pronouncing it an inferior sort.

It is now a source of regret that the scientific men in Java, instead of exerting all their skill and talent in the work of cultivating *C. Calisaya* and *C. lancifolia*, of the value of which there was no doubt, should have bestowed so much pains on a kind which from the first was known to be of very doubtful value, was unknown in commerce, and the cultivation of which ended in loss and disappointment.

The valuable species were found to be much more tender, and more sensitive to external unfavourable influences, than the *C. Pahudiana;* the latter was therefore propagated rapidly, and allowed to outstrip the other kinds in the race, and the consequence was that it gained an immense preponderance.

So numerous are the difficulties of this most important undertaking, that, in spite of the mistakes made at first in Java, the highest praise is due to M. Hasskarl. His successors devoted great ability, no ordinary amount of scientific knowledge, and untiring perseverance to this good work; and, as soon as they received plants of other really valuable species from India, the chinchona

* He left Java in September, 1861, after a residence of six years.

cultivation in Java attained such a measure of success as entitle Dr. Junghuhn and Dr. de Vry to the gratitude of their countrymen.* Dr. Junghuhn died in 1864.

* Dr. Junghuhn published two very interesting reports on the cultivation of the chinchona plants in Java, in the *Bonplandia*, a German botanical journal: the first in Nos. 4 and 5 of 1858, and the second in the numbers for July and August, 1860. I caused these reports to be translated and circulated for the information of those who are entrusted with, or interested in, the chinchona cultivation in India or Ceylon.

CHAPTER IX.

INTRODUCTION OF CHINCHONA PLANTS INTO INDIA. UNSUCCESSFUL ATTEMPTS.

THE distribution of valuable products of the vegetable kingdom amongst the nations of the earth—their introduction from countries where they are indigenous into distant lands with suitable soil and climates—is one of the greatest benefits that civilization has conferred upon mankind. Such measures ensure immediate material increase of comfort and profit, while their effects are more durable than the proudest monuments of engineering skill. With all their shortcomings, the Spaniards can point to vast plains covered with wheat and barley, to valleys waving with sugar-cane, and to hill-slopes enriched by vineyards and coffee-plantations, as the fruits of their conquest of South America. On the other hand, India owes to America the aloes which line the roads in Mysore, the delicious anonas, the arnotto tree, the sumach, the capsicums so extensively used in native curries, the pimento, the papaw, the cassava which now forms the staple food of the people of Travancore, the potato, tobacco, Indian corn, pine-apples, American cotton, and lastly the chinchona:

while the slopes of the Himalayas are enriched by tea-plantations, and the hills of Southern India are covered with rows of coffee trees.

It is by thus adding to the sources of Indian wealth that England will best discharge the immense responsibility she has incurred by the conquest of India, so far as the material interests of that vast empire are concerned. Thus too will she leave behind her by far the most durable monument of the benefits conferred by her rule. The canals and other works of the Moguls were in ruins before the English occupied the country; but the melons which the Emperor Baber, the founder of the Mogul dynasty, introduced into India, and which caused him to shed tears whilst thinking of his far-off mountain home, still flourish round Delhi and Agra. Centuries after the Ganges canal has become a ruin, and the great Vehar reservoir a dry valley, the people of India will have cause to bless the healing effects of the fever-dispelling chinchona-trees, which will still be found on their southern mountains.

The introduction of the chinchona plant into India was surrounded by difficulties from which all other undertakings of a similar nature have been free. When tea was introduced into the Himalayan districts, it had been a cultivated plant in China for many ages, and experienced Chinese cultivators came with it. But the chinchona had never been cultivated; since the discovery of its value in 1638 it had remained a wild forest tree; all information concerning it was solely derived from the observations of European travellers

who had penetrated into the virgin forests; and the only guidance for cultivators in India is to be found in the reports of these travellers, and in the experience slowly acquired by careful and intelligent trials.* Great as these difficulties were, they were probably exceeded by the perils and risks of every description which must be encountered in collecting plants and seeds in South America, and conveying them in safety to India.

But the vast importance of the introduction of these plants into our Indian Empire, and the inestimable benefits which would thus be conferred on the millions who inhabit the fever-haunted plains and jungles, were commensurate with the difficulties of the undertaking. The subject had occupied the attention of the Indian Government from time to time, ever since Dr. Royle in 1839 advocated the introduction of quinine-yielding trees into India, in his work on Himalayan Botany; but it was not until twenty years afterwards, in 1859, that any adequate steps were taken to effect this most desirable end, and to bring an antidote within the reach of the fever-stricken people of India, while adding a new source of wealth to the resources of that great dependency.

The proposal to introduce the chinchona plants into India was first made officially in a despatch from the Governor-General, dated March 27th, 1852. It was

* Dr. Spruce's remark on the eventual necessity of cultivating the chinchona-tree is important. He says, "I have seen enough of collecting the products of the forests to convince me that *whatever vegetable substance is needful to man, he must ultimately cultivate the plant producing it.*"—*Report*, p. 83.

referred to the late Dr. Royle, the reporter on Indian products to the East India Company, who drew up an able memorandum on the subject, dated June, 1852:— "To the Indian Government," he said, "the home supply of a drug which already costs 7000*l.* a year would be advantageous in an economical point of view, and invaluable as affording means of employing a drug which is indispensable in the treatment of Indian fevers. I have no hesitation in saying that, after the Chinese teas, no more important plant could be introduced into India." The only result of this application from India was that the Foreign Office was requested to obtain a supply of plants and seeds from the consuls in South America, and instructions to that effect were sent out to them in October, 1852. In the autumn of 1853 Mr. Mark wrote from Bogotá that some delay would be necessary, and nothing more was heard from that quarter; Mr. Sullivan, the Consul-General in Peru, replied that it would be impossible to accomplish a successful result, through the jealousy of the people; but Mr. Cope, the excellent and venerable Consul-General at Quito, made a more satisfactory and substantial answer, in the shape of a box of chinchona plants and seeds from Cuenca and Loxa. They, however, did not long survive the voyage to England. Seeds of *C. Calisaya*, procured through Mr. Pentland, were sent to the botanical gardens at Calcutta, but did not germinate; and in 1853 six plants of the same valuable species, contributed by the Horticultural Societies of Edinburgh and London, raised from seeds

sent home by Dr. Weddell from Bolivia, were taken out to Calcutta by Mr. Fortune. They arrived in good order, but all died through gross carelessness in their removal to Darjíling. In May, 1853, Dr. Royle drew up a second long and valuable report upon the subject, and the question was then allowed to drop for some years.

It is a curious coincidence that at the very time when Dr. Royle was writing this report I was actually exploring some of the chinchona forests of Peru. But the object of my travels was of an antiquarian and ethnological character, and I was in ignorance of the desire of the Indian Government to procure supplies of those plants, which I then only admired for their beauty.

In March, 1856, Dr. Royle made a final attempt to induce the East India Company to take efficient steps to procure supplies of chinchona plants and seeds from South America; and proposed to employ Dr. Jamieson, the able Professor of Botany in the University of Quito, for this purpose. The lamented death of that eminent botanist Dr. Royle, to whom India owes so much, again put an end to all discussion of the subject for some time; but in 1859 energetic measures were set on foot, which at length effected the desired object fully and completely. Dr. Royle is well known as the author of works on Himalayan botany, on the cotton cultivation and on the fibres of India, and of a 'Materia Medica' containing a valuable article on the chinchona genus, which he caused to be printed separately for circulation in India. For several years he took the warmest

interest in the proposed measures for the introduction of chinchona plants into India, and used every influence at his command to effect this most important object. But he was not destined to see the final achievement of a design which he seems to have had so much at heart. He died in 1857.

CHAPTER X.

INTRODUCTION OF CHINCHONA PLANTS INTO INDIA. MY ARRANGEMENTS AND OBJECTS.

IN 1859, the urgent importance of introducing chinchona cultivation into India was brought to my notice by Mr. Henry Deedes, of the India Office. I gave the subject most careful consideration, and, being convinced that this measure would confer an inestimable benefit on British India, and on the world generally, I resolved to undertake its execution. I was fully aware of the difficulties, but I was certain that, by working steadily and continuously on a settled plan, they would be overcome.

My qualifications for the task which I thus set myself to accomplish, consisted in a knowledge of several parts of the chinchona region and of the plants, an acquaintance with the country, with the people, and with their languages, both Spanish and Quichua. These qualifications had been acquired by previous travels in South America. They would be made more complete by study and experience, and I believed that they would then enable me to originate and superintend all the numerous arrangements in detail, as well as to guide

the general execution of the undertaking, with the aid of carefully selected fellow-labourers.

It was a serious matter for consideration whether the enterprise should be strictly a Government undertaking, or be a private speculation. There were advantages and disadvantages in both methods. By the latter plan, more freedom of action, and more intelligent appreciation of the requirements, would be secured; while the obstruction and wearing delays of official procedure would be avoided. But, on the other hand, the resources of Government, and the great advantage of continuous support and countenance which may often be secured for a Government undertaking, outweighed the drawbacks which occurred to me; and I resolved to submit a proposal to Lord Stanley, the First Secretary of State for India. I accordingly offered my services, and was entrusted with a commission to introduce chinchona cultivation into British India, on April 8th, 1859. Shortly afterwards there was a change of Government, and all the subsequent arrangements were made with the sanction of Sir Charles Wood (afterwards Viscount Halifax) and Mr. T. G. Baring (now Earl of Northbrook), from whom I experienced much kindness. I also received steady and most friendly support from Sir James Hogg, Mr. Mangles, and Sir Henry Montgomery, Directors of the old East India Company and afterwards Members of the Council of India; and from Sir George Clerk, the Under Secretary of State, and subsequently Governor of Bombay when I arrived in India.

It must be remembered that the knowledge of the subject was then far more limited than it is now. All I could do, before maturing the plan of action, was to make myself acquainted with the history and existing condition of the bark trade, and with the botany and chemistry of the chinchona genus as then understood. In this task I received most kind and valuable assistance, on all occasions, from the late Sir William Hooker; from Mr. J. E. Howard, the eminent quinine manufacturer; from Dr. Forbes Watson, the reporter on Indian products at the India Office; and, above all, from Dr. Weddell, who was then the highest authority on the habitat of the chinchona genus. Dr. Weddell, in numerous letters, furnished me with a mass of valuable information.

On the 20th of July, 1859, in a letter to Mr. T. G. Baring, I submitted my plan of operations, a plan in the execution of which I persevered until success had been secured in every particular. I, of course, foresaw the probability of failure in one or more points, but I was fully resolved that no failure should be accepted as final, and that, whether through Government or private agency, every detail of the undertaking, as I then submitted it, should be eventually carried out.

It was uncertain what effect transplantation might have on the product of chinchona bark. One high authority was of opinion that chinchona-trees might cease to yield quinine when transplanted to India. I also bore in mind that there were febrifuge alkaloids, other than quinine, in some barks, and that these were

also efficacious in curing fever. I decided, therefore, that it was necessary to procure and introduce into India all the species known to commerce. The plan, for which I applied for sanction, was to make a collection of plants and seeds of all the chinchonæ known to commerce through the instrumentality of qualified agents. This would entail the despatch of five agents; to Bolivia or Caravaya for the Calisaya plants, to Huanuco in Peru for the grey barks, to Loxa in Ecuador for the crown barks, to Huaranda in Ecuador for the red barks, and to Popayan for the Colombian barks. These five agents were to work simultaneously under my general superintendence, and a special steamer was to be supplied to convey the collections of plants and seeds, from the five ports of Islay, Callao, Payta, Guayaquil, and Buenaventura, direct to India across the Pacific Ocean. If the scheme failed at one or more points—which, considering the enormous difficulties, was quite probable—my plan was to repeat the work in the next season, and, if necessary, in the next and the next, until complete success was secured.

I was fully determined that the whole plan should, sooner or later, be carried out. If it had been adopted in its entirety, as I recommended, the undertaking would have been completed in a quarter the time, and at a tenth of the expense. But the delay in obtaining consideration for my plans prevented me from maturing them fully before leaving England. I received sanction for the expeditions into the Calisaya and red bark

regions in good time, and made all the necessary arrangements. But I failed to obtain any answer to my proposals for the Huanuco and Colombian regions, which I submitted on May 13th, 1859, until the end of the following September; and instead of steps being taken to furnish me with a steamer, I was only authorised to charter a sailing vessel myself, if I could find one on the west coast of South America. Subsequently, in a letter, dated May 17th, 1860, I was empowered to charter a steamer, but this letter never reached me until after my arrival in India. In point of fact, there was no steamer available on the west coast of South America at that time; and it was necessary that the Government should make arrangements for the conveyance of the plants and seeds to India. This was not done, although H.M.S. *Vixen* was at Callao and about to go home, and she might have perfectly taken the precious cargo to India, direct; thus ensuring its safe transit. The alternative was a most perilous and roundabout series of voyages, involving four transshipments and great changes of climate, by Panama to England, and then by Egypt to India. Such a journey made success, as regards the plants, very precarious and doubtful, and the loss of a large percentage almost certain. There would be less chance of loss in the transmission of seeds.

When I left England in December, 1859, my final arrangements were to proceed, with a practical gardener, into the forests of Caravaya or Bolivia to obtain plants and seeds of the *C. Calisaya* and other valuable species

of that region: to employ another qualified collector, also with a practical gardener, to collect plants and seeds of the *C. succirubra* or red bark species in Ecuador; and I hoped to be able to make arrangements for obtaining the grey bark species in the forests of Huanuco and Huamalies. From the causes already indicated, I was forced to defer the measures for procuring the crown bark and Colombian species until a future year. I brought out Wardian cases for the Calisaya plants to be shipped at Islay, the grey bark plants at Callao, and the red bark plants at Guayaquil, making all needful arrangements on the coast. Mrs. Markham, who accompanied me to South America, remained at Arequipa while I was in the forests east of the Andes, to conduct correspondence and organise the work, especially in the Huanuco district, which I was obliged to leave incomplete.

All the details were arranged with the strictest attention to economy; and the payments to collectors and gardeners were on the most moderate scale. I considered that if they failed, the very small remuneration would be sufficient; while success would ensure such valuable and remunerative results, that I could safely rely on the generosity of the Government for the suitable recognition of their services. The sequel will show how far I was justified in this reliance.

I will conclude this chapter by stating, briefly and distinctly, my objects in the introduction of chinchona cultivation into India. Those objects were not remunerative returns, but the good of the people. I

desired to make the febrifuge trees natives of all parts of our eastern dominions where the conditions are suitable for their growth; and to bring the febrifuge within reach of all ranks of the people.

The measures which I thought necessary from the first, and which I have since continuously striven to bring to perfection, were:—

1. The introduction into India of *all* chinchona species known to commerce, because it was uncertain which would eventually prove to be best adapted for cultivation in the new country. Even species which do not yield quinine were collected, because the other chinchona alkaloids also possess febrifuge virtues.

2. The establishment of Government plantations wherever suitable sites could be found in India, to form centres for the distribution of plants and seeds, and for ascertaining the best methods of cultivation.

3. The manufacture, in India, of a form of the febrifuge combining, in the highest attainable degree, efficacy and cheapness; so that there may be abundant supplies within reach of all classes of the people.

CHAPTER XI.

MY FELLOW-LABOURERS.

THE early success of the enterprise mainly depended upon the selection of qualified agents, and in this respect I was most fortunate. No one, engaged in important work, ever had more able, loyal, and disinterested fellow-labourers to assist him.

The Calisaya region, in the Peruvian province of Caravaya and in Bolivia, is the most distant from the coast and the most difficult of access, while the bark which comes from it was then held to be richest in febrifuge alkaloids. For the duty of collecting plants in this region, and establishing them in Wardian cases, I selected an intelligent and experienced young gardener named John Weir, who was strongly recommended to me by Mr. Veitch. I myself determined to accompany him and personally superintend this branch of the work, because it was surrounded by special difficulties, and because it was important that I should collect information respecting the climate and soil of this typical chinchona region, and the habits of the various species.

For the work in the forests of Ecuador, containing the *C. succirubra* or red bark species, I was so fortunate

as to secure the services of Dr. Spruce, an eminent botanist and most intrepid explorer. Richard Spruce is a native of Welburn, near Castle Howard, in Yorkshire. From his early youth he diligently collected and studied the plants of his neighbourhood, especially investigating the muscology of Yorkshire, and afterwards of the Pyrenees. In June 1849 he sailed from Liverpool for South America, and, during the succeeding ten years, he was occupied in studying and collecting the rich vegetation of the Amazonian valley including the Rio Negro, exploring the courses of unknown rivers, constructing maps, and bringing together a mass of valuable geographical information. In 1856 he was at Tarapoto, in the valley of the Huallaga, and in 1857 he descended that river to the Marañon, thence ascending the Pastasa and Bombanasa, and traversing the vast forests of Canelos to Baños in Ecuador. In this disastrous journey, which occupied a hundred days, Dr. Spruce had to abandon all his goods in the forest, to escape perishing of hunger at the passage of swollen rivers. In January 1858 he removed to Ambato, which for more than two years was his point of departure for excursions in the Quitenian Andes. His researches into South American vegetation have been the most important since the days of Humboldt, not merely for the number of species collected, amounting to upwards of 5000, but for the number of new generic forms with which he enriched science. He also investigated the economic uses of the plants, and his discoveries cleared up several doubtful questions of origin as to interesting

genera and species. His observations, made on the spot and attached to the preserved specimens, were numerous and of great scientific value. Complete sets of these specimens were sent home and deposited in the Royal Herbarium at Kew. Dr. Spruce also collected vocabularies of twenty-one native languages of the Amazon valley, he took meteorological and hypsometrical observations throughout the vast region he traversed, mapped three previously unsurveyed rivers, and made notes of travel of the aspects and capabilities of the various countries, and of the customs, food, trade, and agriculture of the inhabitants. The services of Dr. Spruce were most valuable, because this accomplished botanist and traveller was competent to furnish a botanical description of the *C. succirubra* and a scientific account of the forests where it flourishes. He agreed to perform this duty for a sum of money which, regarded as remuneration, was merely nominal; and I shall ever look upon my good fortune in securing Dr. Spruce's able co-operation as the most fortunate event connected with my conduct of the enterprise.

I considered it necessary that a practical gardener should assist Dr. Spruce in the forests, and establish the plants in the Wardian cases at Guayaquil, as well as accompany them on the voyage to India. For this work I selected a very able and painstaking Scotch gardener named Robert Cross, who was recommended to me by Sir William Hooker. He went out from England, and joined Dr. Spruce in Ecuador.

For the collection of plants yielding grey barks in

the forests of Huanuco, I obtained the services of Mr. Pritchett, just before leaving England. He was to follow me, and receive his instructions at Lima. Mr. Pritchett had previously been for some time in South America, and was well acquainted with the Huanuco region. He had recently acted as agent of the Land Warrant Holders for the Ecuador Land Company; and had examined and reported upon the tracts granted to the Company in that Republic.

My arrangements were thus completed for the first year, during which I hoped to get the work completed in three out of the five chinchona regions. I was to proceed to the Calisaya region, accompanied by John Weir. The red bark forests were to be penetrated by Dr. Spruce, with Robert Cross as an assistant. The Huanuco country was to be visited by Mr. Pritchett. The following chapters contain narratives of the proceedings of these several explorers, as well as some account of the services of Mr. Ledger, who, although not under my orders, also zealously co-operated for the same end, and gave useful and important aid to the cause.

CHAPTER XII.

JOURNEY ACROSS THE ANDES, FROM AREQUIPA TO PUNO.

THE route to the Calisaya forests is from the desert port of Islay, across the maritime cordillera of the Andes to Lake Titicaca. Now there is a railroad for the whole distance, but in 1860 there was only a mule track over the great sandy desert to Arequipa, and then across the lofty mountain passes and frozen plains to the Titicaca basin. I left the Wardian cases at the Islay Consulate, with soil ready to receive the plants, and started for the interior on March 6th, 1860, reaching the city of Arequipa two days afterwards. Here Mrs. Markham remained to conduct all the business on the coast, and especially to furnish Mr. Pritchett with instructions and funds when he should arrive from England; and, on the 23rd of March, Weir and I began the ascent of the cordilleras by the long zigzag path called the "alto de los Huesos." The journey entailed rides of many hours over a succession of wild desolate plains, in snow and hail storms, until the highest part of the road was reached, called the "alto de Toledo," 15,590 feet above the level of the sea. Some glorious snowy peaks appeared through the gloom at sunset, and after several weary hours in the darkness we at length reached the

post-house of Cuevillas. At this elevation there grows a little lowly plant with yellow flowers, an asclepiad (*Pentagonium flavum*). Lower down the hills are covered with tufts of coarse grass (*Stipa ychu*). There is a shrubby composita (*Baccharis Incarum*) used for fuel, and called *tola* by the natives, another composita (*Merope piptolepis*), and an oxalis in the crevices of the rocks (*Oxalis nubigena*); and the plains furnish pasture for large flocks of sheep and llamas.

In the neighbourhood of Cuevillas there are large sheep-farms, one called Toroya, near the "alto de Toledo," and another called Tincopalca, farther on. The sheep, at this enormous height, lamb in March and July, and, of the March lambs, usually about fifty per cent. survive. Beyond Cuevillas there are two large Alpine lakes, whence a river flows down into Titicaca, and we thus crossed the waterparting between the Pacific and the great lake. The scenery is grand and desolate, reminding me, in some respects, of the interior of Cornwallis Island in the Arctic Regions. The road passes between the two lakes, and we reached the post-house of La Compuerta as the afternoon rain commenced.

The gorge in which the La Compuerta post-house is situated is the only outlet for the waters of the lake. Mountains of great height rise up on either side, clothed, at this season, with herbage of the richest green, while ridges of scarped cliffs of dark porphyritic rock crop out at intervals. The river dashes noisily over huge boulders, and near its left bank are the rough stone buildings of the post-house. Great quantities of ducks,

gulls, coots, godwits, and sandpipers frequent the shores of the lake. The postmaster supplied *alfalfa* for the mules, and a *chupé* consisting of potatoes and salt mutton for the travellers, at exorbitant prices; the mules were freed from their cargoes, which were placed within the porch, ready lashed up in their *redecillas* or hide nets; and we were soon rolled up in blankets and ponchos, while the snow continued to fall unceasingly through the early part of the night. When we got up next morning the thermometer was at 31° Fahr. indoors.

Starting at dawn, we descended the gorge, passing two ruined mining establishments, San Ramon and Santa Lucia, into green plains with large flocks of sheep scattered over them.

In these uninhabited wilds it is an event to meet a traveller, and his appearance is the signal for a succession of questions and answers. We here passed a *cavallero,* in whose dress and general appearance we saw a reflection of our own, excepting the comforters. He wore a large poncho of bright colours, reaching nearly to his heels; a broad-brimmed felt hat with a blue cotton handkerchief passed over it, and tied in a knot under his chin; an immense woollen comforter passed round his throat and face, until nothing appeared but his eyes; a pair of woollen gaiters, bright green, with black stripes; and huge spurs. He was an officer on his way to Arequipa, and complained of the severity of the weather and the heaviness of the roads. After a short conversation the traveller passed on, followed by his cargo-mules, and soon became a speck in the distance.

In the afternoon we came to the first signs of cultivation, since leaving the valley of Cangallo, in the neighbourhood of the great sheep-farm of Taya-taya—patches of quinoa, barley, and potatoes, with the huts of Indians scattered amongst them; and, crossing a rocky ridge, we came in sight of a vast swampy plain, with the little town of Vilque, at the foot of a fine rocky height, in the far distance, which we reached at sunset. The long rows of thatched brown huts dripping with rain, and the muddy streets, looked melancholy. But at the time of the great fair, in June, Vilque presents a very different appearance. The plains, for several miles beyond this little town, were so swampy as to be rendered almost impassable. It was with the greatest difficulty that we made our way across them, constantly wading and splashing through water, and in some places sinking so deep in the adhesive mud, that it was not without desperate exertions that the mules could extricate themselves. At length we came to a rocky ridge which bounded the vast pampa of Vilque, and continued our journey over rather drier ground.

Since leaving La Compuerta we had been continually descending; the vicuñas had disappeared, as they confine themselves to the loftiest and wildest parts of the cordillera; but in the lower region between Vilque and Puno, the feeling of desolation and solitude is dissipated by the numbers of birds which enliven the country, and by the increased quantity and variety of wild flowers.

The *lecca-leccas* or plovers were very numerous, screaming shrilly as they flew in circles, or ran along the ground. In the clefts of the rocks there were many birds, like creepers, called *haccaello* by the Indians, and *pito* in Spanish—beaks curved downwards, black on the top of the head, white underneath, red at the back of the neck, speckled wings, white breast, and a black line from the beak to the back of the neck. We also saw many small green paroquets, bright yellow finches called *silgaritos*, a kind of partridge called *yutu*, and, above all, the glorious *coraquenque* or *alcamari*, the royal bird of the Yncas, whose black and white wing-feathers surmounted the imperial *llautu* or fringe of the sovereigns of Peru. The *alcamari* is a large and noble-looking bird of prey, with a scarlet head, black body, and long wing-feathers of spotless white. Wherever the plains are intersected by ridges of rocky cliffs, which is frequently the case, there are swarms of large rodents, called *biscaches*, which sat on their hind legs, and looked about inquisitively as we rode past.

Riding over several wide grassy plains, and passing the village of Tiquillaca, we arrived at the banks of the river Tortorani, which was so swollen as to be quite impassable. By following its course for about half a mile, we came to a place where the whole volume of water precipitates itself down a sheer declivity of 250 feet, and forms a magnificent cascade. A league below the falls we found a bridge, and, at sunset, we came in sight of the great lake of Titicaca, with the snowy range beyond. A steep zigzag descent leads down to the city

of Puno, which is close to the shores of the lake, and hemmed in by an amphitheatre of argentiferous mountains.

Puno, the capital of the department, owes its origin and former prosperity to the rich veins of silver-ore in the surroundiug country. It is approached, from the north, by a stone archway built over the road by General Deustua, who was Prefect in 1850; and the streets slope by a gradual descent towards the lake. The houses are built of small-sized brown *adobes*, with roofs of thatch or red tiles, and courtyards very neatly paved with round pebbles and llama's knuckle-bones in patterns. There are scarcely any with more than a ground-floor, and the rooms open on to the court; but, though at this elevation, 12,874 feet above the sea, it is extremely cold at night, stoves are unknown; and the unusual luxury of a fireplace, which exists in one house, is merely a luxury to the eye, for it is never lighted. The streets are clean and well paved, and the stone church in the *Plaza*, dating from 1757, has an elaborately carved front and two towers. In another plaza is the college, a large building with an upper story, also built by General Deustua; and both these public squares have bronze fountains erected by the Government of General Echenique, the late President, besides drinking fountains in the corners of several of the streets. The water is excellent.

Puno is surrounded by heights covered with patches of potatoes, barley, and quinoa (*Chenopodium Quinoa*), the huts of Indians being interspersed amongst them; and

immediately over the town there is an isolated rocky ridge of carboniferous limestone perforated by several natural caverns, called the Huassa-pata. The shores of the lake are a few hundred yards from the town, and at the little port there are always a number of balsas, made of large bundles of reeds tied together, with a reed sail.* The view to seaward is, however, confined by the peninsula of Capachica, and two islands at the mouth of the bay of Puno. A canal to enable balsas to come up nearer the town was made by the Spanish Intendente Gonzalez Montoya in the beginning of the present century.†

The flora of a country which, though within the tropics, is at an elevation of nearly thirteen thousand feet above the sea, must necessarily be meagre, and the few plants are lowly and inconspicuous. I noticed the following in the immediate vicinity of Puno. The only tree was one of stunted growth, with a pretty pink and white flower, and dark-green leaves, almost white underneath, called "oliva silvestre" by the Spaniards, and *ccolli* in Quichua (*Buddlea coriacea*); and of these there were not more than a dozen, sheltered behind walls.

I remained for some time at Puno, in order to collect information, and came to a determination respecting the best course to pursue in the performance of the service

* M. de Castelnau says that vessels exactly resembling those of Lake Titicaca are represented on the tomb of Rameses III. at Thebes.

† Gonzalez Montoya was the best Governor that Puno has ever known. He was a benevolent as well as a determined man, and abolished the *mitas*, or drafting of Indians for forced labour in the mines of Potosi. When ordered by the Government to restore the *mitas*, he replied, "Obedesco pero no cumplo."

on which I was employed. The supply of the bark of *Chinchona Calisaya* trees is procured from the forests of Munecas, Apollobamba, Yuracares, Larecaja, Inquisivi, Coroico, Caupolican, Ayopaya, and the *yungus* of La Paz in Bolivia; but I found that the difficulties in the way of making a collection of plants and seeds in these districts would be very great. As a considerable part of the revenue of Bolivia is derived from the bark trade, which is not the case in Peru, the Bolivians are exceedingly jealous of their monopoly, and vigilantly watch to prevent any infringement of it. The exportation of plants and seeds is prohibited by their laws. Moreover there was an imminent prospect of a war between Peru and Bolivia; a large army was massed in three divisions —at Puno under General San Roman, at Vilque under Beltran, and at Lampa under Frisancho; and, as soon as hostilities commenced, it would have been next to impossible for a private person to preserve his mules from seizure. This war did not actually take place, but Linares, the President of Bolivia, issued a decree on May 14th prohibiting all traffic, or the passage of travellers, from one country to the other;* a decree which was strictly enforced, and which would have rendered it impracticable at that time to have conveyed myself and companion, with laden mules, from Bolivia to the coast.

While these objections weighed against an attempt to

* The Peruvian Government answered this decree in a noble spirit, by declaring that they would not retaliate, but, on the contrary, would assist commercial traffic between the two countries by every means in their power. Linares rescinded his edict on October 17th.

collect plants in the forests of Bolivia, I found that, with regard to the chinchona forests of the Peruvian province of Caravaya, on the frontier of Peru and Bolivia, the facilities for such an enterprise would be much greater. I had reason to believe, though I afterwards found myself in error, that, as there was no bark trade in Peru of any importance, no jealousy would be felt at the nature of my mission. Any hostile proceedings on the Bolivian frontier would not materially affect the route between the Caravaya forests and the coast; and, above all, Caravaya is much nearer and more accessible, as regards an available seaport, than any part of the chinchona forests of Bolivia. This latter point was of the very greatest importance, because success depended chiefly on the rapidity with which the plants could be conveyed across the frozen plains of the cordilleras. I knew from Dr. Weddell that, though the bark trade from Caravaya has now ceased, and bark from that district is of no market value, owing to a foolish habit of adulteration among speculators in former times, yet that young plants, and trees bearing fruit, of the *Chinchona Calisaya*, and other valuable species, were abundant in the forests of that province, as far north as the valley of Sandia.

I, therefore, after much anxious consideration, determined to proceed direct from Puno to the forests of Caravaya.

CHAPTER XIII.

JOURNEY FROM PUNO TO CRUCERO, THE CAPITAL OF CARAVAYA.

On April 7th, 1860, we left Puno on the road to the chinchona forests of Caravaya. There are three modes of travelling in Peru: one by purchasing all the required mules and employing servants; the second by hiring an *arriero*, or muleteer, who supplies the mules at so much for the journey; and the third by using the wretched animals which are provided at the post-houses, and changing them at each stage, but this can only be done on the main roads. The latter way, though the least comfortable, is by far the most economical, and I therefore determined to adopt it, yet I should probably have hesitated had I known the trouble it would entail.

Our first stage was to Paucar-colla, a village near the banks of lake Titicaca. Just beyond there is a stream called the Yllpa which, in the dry season, scarcely wets the mule's hoofs, but at this time of year it was swollen into a broad river, and it was necessary to cross on reed balsas with the luggage, while the mules swam. From the Yllpa to Juliaca there are broad plains extending to the shores of the lake, with the village of Hatun-colla,

the ancient Ynca capital of the Collao, on one of the last spurs of the cordillera to the west.

These wide expanses, in the rainy season, are swampy and half submerged. They were covered with flocks and herds, with huts and out-buildings scattered over them, and surrounded by mud walls. Here and there we passed pretty little cow-girls and shepherdesses, now dressed in the Quichua, not the Aymara, costume. Some of these little maidens, as they stood by the way-side spinning wool, had such pretty faces, with the rosy colour showing through their soft, brown skins, and their figures were so graceful and dignified, that they strongly reminded me of the pictures of young Ynca princesses in the church of Santa Ana at Cuzco :—

"La vi tan fermosa
Que apenas creyera
Que fnese vaquera
De la Finojosa."

Potatoes, quinoa, and barley were cultivated in the skirts of the hills bordering on the plains.

A few miles north of Juliaca there is a large river, formed by the junction of those of Lampa and Cavanilla, the latter being the same which rises in the lake on the road between Arequipa and Puno, and flows by the post-house of La Compuerta. We crossed it in a reed balsa while the mules swam. Beyond the river is the great plain of Chañucahua, which was covered with large pools of water, at this season frequented by ducks and sandpipers. Close under the mountains which bound it on every side, were a few

sheep-farms, and the sheep roamed at will over many leagues of pasture land. At the northern extremity of the plain the road ascends and descends a range of steep hills, and, turning a rocky spur, I came in sight of the town of Lampa. It was just sunset; the tall church-tower rising over the town, and a stone bridge spanning the river, were clearly defined by the crimson glow in the western sky, while the lofty peaked mountains forming the background were capped by masses of black threatening clouds. At that moment a tremendous thunderstorm, with flashes of forked lightning and torrents of rain, burst over the town.

Lampa is the capital of a province in the department of Puno, and I was hospitably received by the Sub-prefect, Don Manuel Barrio-nuevo, who occupied a good house in the plaza. A portion of the army of the South was quartered in the town; and the General came every evening to have tea with the Sub-prefect and his lady, a handsome Arequipeña. On these occasions the party consisted of General Frisancho and several officers, and ladies who came attended by their little Indian maids, carrying shawls, and squatting on the floor in corners during the visit. After tea and conversation the company generally sang some of the *despedidas* and love-songs of their national poet Melgar, in parts; and one young lady sang the plaintive *yaravis* of the Indians in Quichua.

The church of Lampa is a large building of stone, dating from 1685, with a dome of yellow, green, and

blue glazed tiles, of which I was informed there was formerly a manufactory in Lampa. The tower is isolated, and about twenty yards from the church, apparently of a different date. Rows of Indian girls, in their gay-coloured dresses, were sitting in the plaza before their little heaps of *chuñus*, ocas, potatoes, and other provisions, amongst which, at the season of Easter, there are always great quantities of herbs gathered on the mountains, possessing supposed medicinal virtues. Among these a fern, called *racci-racci*, is used as an emetic; *churccu-churccu*, a small wild oxalis, is taken as a cure for colds; *chichira*, the root of a small crucifer, for rheumatism; *llacua-llacua*, a composita, for curing wounds; *quissu*, a nettle, used as a purgative; *cata-cata*, a valerian, as an antispasmodic; *tami-tami*, the root of a gentian, as a febrifuge; *quachanca*, a euphorbia, the powdered root of which is taken as a purgative; *hama-hama*, the root of a valerian, said to be an excellent specific against epilepsy;* and many others, the native names of which, with their uses, were given me, but I was unacquainted with their botanical names. Generally, when the name of a plant is repeated twice in Quichua it denotes the possession of some medicinal property.

On the morning of our departure from Lampa the ground was covered with snow, which was slowly melting under the sun's rays. Immediately after leaving the town the path winds up a steep mountain range called Chacun-chaca, the sides of the precipitous

* The three latter are also mentioned by Haënke.

slopes being well clothed with *queñuar* trees (*Polylepis tomentella*, Wedd.), which are gnarled and stunted, with dark-green leaves, and the bark of the trunk peeling like that of a yew. Their sombre foliage contrasted with the light-green tufts of *stipa*, and the patches of snow. The pass was long and dangerous, with little torrents pouring down every rut; and on its summit was the usual *pacheta*, or cairn, which the Indians erect on every conspicuous point. The path descends on the other side into a long narrow plain, with the hacienda of Chacun-chaca on the opposite side. The buildings are surrounded by *queñuar* trees, and in their rear two remarkable peaked hills rise up abruptly, clothed with the same trees, with ridges of rock cropping out at intervals. Their sides were dotted with cattle, tended by pretty little cow-girls, armed with slings, and some of them playing the *pincullu*, or Indian flute. The plain was covered with long grass, in a saturated and spongy state, and groves of *queñuar* trees grew thickly in the gullies of the mountains on either side. After a ride of several leagues over the plain, latterly along the banks of the river Pucara, I turned a point of the road, and suddenly came in sight of the almost perpendicular mountain, closely resembling the northern end of the rock of Gibraltar, which rises abruptly from the plain, with the little town of Pucara nestling at its feet. The precipice is composed of a reddish sandstone, upwards of twelve hundred feet above the plain, the crevices and summit clothed with long grass and shrubby queñuas. Birds were whirling in circles at a great height above

the rock, which, in the Spanish times, was famous for a fine breed of falcons, which were carefully guarded and regularly supplied with meat. They tell a story at Pucara that one of these birds was sent to the King of Spain, and that it returned of its own accord, being known by the collar.

Pucara means a fortress in Quichua; and here Francisco Hernandez Giron, the rebel who led an insurrection to oppose the abolition of personal service amongst the Indians, was finally defeated in 1554. The town is a little larger than Juliaca, with a handsome church in the same style, and a fountain in the plaza. I dined and passed the evening with the aged cura, Dr. José Faustino Dasa, who is famous for his knowledge of the Quichua language, in its purest and most classical form. The fame of Dr. Dasa's learning, in all questions connected with the antiquities of the Yncas and the Quichua language, had reached me in England, and I was glad to obtain his valuable assistance in looking over a dictionary of the rich and expressive language of the Yncas, on which I had been working for some time.

Owing to the diminution of the aboriginal population in Peru, and the constantly increasing corruption of the ancient language through the substitution of Spanish for Quichua words, the introduction of Spanish modes of expression, and the loss of all purity of style, that language, once so important, which was used by a polished court and civilised people, which was spoken through the extent of a vast empire, and the use of which was spread by careful legislation, is now dis-

appearing. Before long it will be a thing that is past, and perhaps fade away entirely from the memory of living generations. With it will disappear the richest form of all the great American group of languages, no small loss to the student of ethnology. With it will be lost the traditions which yet remain of the old glory of the Yncas, the elegies, love-songs, and poems which stamp the character of a once powerful, but always gentle and amiable race.

Dr. Dasa had a large collection of the finches, and other birds of the loftier parts of the Andes, hanging in wicker cages along the wall of his house. Amongst them were a little dove called *urpi;* the bright yellow little songster called *silgarito* in Spanish, and *chàyña* in Quichua;* the *tuya,* another larger warbler; the *chocclla-poccochi* or nightingale of Peru; and a little finch with glossy black plumage, pink on the back, and whitish-grey under the wings. He also had some small green paroquets, with long tails and bluish wings, which make their nest under the eaves of roofs, at a height of fourteen thousand feet above the sea. At Pucara some of the inhabitants have small manufactories for making glazed earthenware basins, pots, plates, and cups,† which find an extensive market in the villages and towns of the department of Puno, and which will probably long hold their own against the same kind of coarse wares from Europe or the United States.

* *Chrysomitris Magellanica.*

† One of the manufacturers, Don Manuel Zenon Ramos, has been very active in seeking for instruction, designs, and models from Europe.

From Puno to Pucara I had travelled along the main-road to Cuzco; but, at the latter place, I branched off to the eastward, to pass through the province of Azangaro to that of Caravaya. The main-road continues in a northerly direction, crosses the snowy range of Vilcañota near Ayaviri, and descends the valley of the Vilcamayu to Cuzco. At Pucara I left post-houses and post-mules behind me, for they only exist on the main-roads between Arequipa, Puno, Cuzco, and Lima; henceforth I had to depend on being able to induce private persons to let out their mules or ponies to me.

About 500 yards from the town of Pucara is the river of the same name, which flows past Ayaviri in the mountains of Vilcañota. It was very full, and eighty yards across. The mules swam, and we had to cross in a rickety balsa made of two bundles of reeds, which had to go backwards and forwards five times before all the gear and baggage was on the eastern side. After riding over a plain which became gradually narrower as the mountains closed in, I began the ascent of a rocky *cuesta*, with a torrent dashing down over huge boulders into the plain. There was a splendid view of the distant rock of Pucara, with the snowy peaks of the Vilcañota range behind. A league further on there was an alpine lake, with a fine peaked cliff rising up from the water's edge. There were many ducks and widgeons, and large coots were quietly busy, swimming about and building their nests on little reed islands; also jet-black ibises, with dark rusty red heads and long curved bills. After a ride of several leagues over a grassy country

covered with flocks of sheep, I reached the summit of a range of hills, and got a distant view of the town of Azangaro, in a plain with several isolated steep grassy mountains rising from it, and the snowy Andes of Caravaya in the background. After a very wearisome descent I reached the plain, and, riding into Azangaro, was most hospitably and kindly received by Don Luis Quiñones, one of the principal inhabitants.

The region which I had traversed between Puno and Azangaro consists of a series of grassy plains of great elevation, covered with flocks and herds, and watered by numerous rivers flowing into lake Titicaca. These plains are separated by several mountain-ranges, spurs from the cordillera, which sometimes run up into peaks almost to the snow-line, and at others sink into rocky plateaux raised like steps above the plain. What strikes one most in travelling through this country is the evidence of the vast population it must have contained in the days of the Yncas, indicated by the ruined remains of *andeneria,* or terraces for cultivation, rising in every direction tier above tier up the sides of the hills. But it is now almost exclusively a grazing country, and the Indians, employed in tending the large flocks of sheep, only raise a sufficient supply of edible roots for the consumption of their families, and the market of the nearest town. Frequently the shepherds are what are called *yanaconas,* or Indians kept to service by the owners of the flocks, which vary from 400 to 1000 head. The condition of this class of Indians is very hard, as they get only a monthly allowance of an

arroba of chuñu (frozen potato) or quinoa, and a pound of coca, or four dollars a month in money.

Puno, Juliaca, Lampa, Pucara, and Azangaro, are all between 12,800 and 13,000 feet above the sea. Between March 28th and April 15th, the indications of the thermometer at these places were as follow :—

Mean temperature . . .	52½°
Mean minimum at night .	37¼
Highest observed . . .	58
Lowest	37
Range	21

Azangaro is the capital of the province of the same name. There is a tradition that, when the Indians were bringing gold and silver for the ransom of the Ynca Atahualpa, they received news of his murder by Pizarro, at Sicuani, and at the same time orders came from Ynca Manco, who was at Cuzco, to remove the treasure to a greater distance; and that they buried it near this town. *Asuan* is "more," *carun* "distant;" hence *Azangaro.*

Azangaro is *par excellence* the city of hidden treasure. The houses are built of mud and straw, and thatched with coarse grass (*stipa ychu*), the better sort being whitewashed. To the north of the town there is a long ridge of rocky heights; to the south an isolated peaked hill nearly overhangs the town; to the east is the river; and to the west is a plain bounded by the mountains towards Pucara. The church, in the plaza, is like a large barn outside, with walls of mud and straw, and a tower with broad-brimmed red-tiled roof; but on entering it I was astonished at its extraordinary

magnificence, so entirely out of proportion to the wealth or importance of this little town. The nave is lined with large pictures on religious subjects, by native artists, in frames of carved wood, richly gilt. The elaborate gilded carving was very striking; the leaves, bunches of grapes, and twisted columns, being the workmanship of the famous carvers of Cuzco. Over the arch leading to the chancel there is a picture representing the Triumph of the Faith, in bright colours. The high altar is plated with massive silver, with gilded columns, pictures, and images, in gorgeous profusion up to the roof. On either side are two very remarkable pictures, filling the walls between the altar and the chancel-arch. On the right an allegorical picture, and the Shepherds worshipping. One figure, in the latter picture, a girl holding a basket on her head, is of great merit, and exactly resembles the 'Santa Justa' of Murillo in the Duke of Sutherland's collection. On the left is a picture of the 'Woman taken in Adultery,' and an excellent copy of the well-known 'Worshipping of the Magi,' by Rubens, in the Madrid gallery. In a side chapel there is a copy of Leonardo da Vinci's 'Last Supper,' with portraits of two caciques—the heads of the two great families of Azangaro—with their wives, one of them very pretty, looking on in a corner. These copies, which are excellent, must have been procured from Europe at very great expense.

The author of all this magnificence, according to the inscription on his portrait, which is fixed in a handsome gilt frame by the side of the chancel-arch, was the

Bachiller Dr. Don Basco Bernardo Lopez de Cangas, a native of Cuzco, and Cura of Azangaro. The interior decorations were completed on January 12th, 1758, and the cura died in 1771. He must have been possessed of enormous wealth, to have enabled him thus to beautify and adorn his church with such lavish profusion.

In the days of the Yncas the two great families of Azangaro, whose heads ranked as Curacas, were the Murumallcucalcinas and Chuquihuancas; and they retained the office of cacique until recent Spanish times. The Murumallcucalcina family is now extinct: they lived in the town, and a portion of their house still remains, called the *Sondor-huasi*, dating from the time of the Yncas, and the greatest curiosity in the place. It is a circular building, about twelve feet in diameter, with walls twelve feet high, of mud and straw, very strong and thick. The dome-shaped roof of thatch also dates from the time of the Yncas. The outside coating consists of a layer of *stipa ychu*, two feet thick, placed in very regular rows, and most carefully finished, so as to present a smooth surface to the weather. Next there is a thick layer of the same grass placed horizontally, netted together with reeds; and finally an inner perpendicular layer; the whole thatch being five feet thick. The interior framework consists of twelve perfect circles of bent wands, with others descending in curves from the apex of the roof to the crest of the wall, and where they cross there are lashings of a tough reed. The whole is finished with most admirable neatness, forming

a perfect dome. This is the only roof of the time of the Yncas still remaining in Peru, and hence its great importance in an antiquarian point of view. It has been said that the colossal and highly-finished masonry of the Yncas, and their poor thatched roofs, formed a barbaric contrast; but the Sondor-huasi proves that their roofs rivalled their walls in the exquisite art and neatness of their finish. The Sondor-huasi is now in a very dilapidated state, and is used as a kitchen by the degenerate collateral heirs of the old caciques.

The Chuquihuanca family had a country house about a league from Azangaro, which was destroyed by the army of Tupac Amaru in 1780, because the Chuquihuancas deserted their countrymen and adhered to the Spanish cause. I accompanied my host, Don Luis Quiñones, and the whole of the society of Azangaro, to a picnic at the ruined house of the Chuquihuancas; and it was amusing to see all the masters of families, the Sub-prefect Don Hipolito Valdez, the judge, the cura, and every one else, locking the great folding-doors leading into their *patios*, and putting the keys into their pockets. Azangaro was entirely deserted. We were all well mounted, and there were fourteen young ladies of the party, fresh pleasant girls, who thoroughly enjoyed a good gallop. The ruined house was in a corner of the plain, and surrounded on three sides by steep overhanging cliffs. There are the remains of a house, with a long corridor of brick arches, behind which several broad terraces rise up the face of the cliff, which are still ornamented with some fine *oliva silvestre* and *queñuar*

trees, a few ancient apple trees, and a dense growth of bright-yellow compositæ, and solanums with a purple flower. A noisy torrent foamed down the cliffs and over the terraces to the plain below. It was a very pretty spot, but in a most desolate condition, and many small doves made their nests in the trees. Lupins (*ccerra**) and nettles (*itapallu*) were growing in the crevices of the rocks. We had an excellent and very merry dinner; a large amount of Moquegua wine, and of the better-clarified and more generous liquor from Don Domingo Elias's vineyards at Pisco, was drunk; and guitar-playing and samocueca-dancing finished the day's entertainment. We returned to Azangaro after dark. Don Luis assured me that the people of this little town were like one family; and that, though election-time or periods of civil dissension sometimes caused estrangement amongst them, the habitual concord and friendship always returned when the excuse for alienation had passed away.

Azangaro is a great cattle-breeding province, and there is a considerable trade in cheeses with Arequipa and other parts. I found very great difficulty in procuring animals to enable me to continue my journey. At length I succeeded in hiring four miserable-looking, vicious, undersized ponies; and, having crossed the Azangaro on balsas, by far the largest river I had passed over since leaving Puno, the way led across the rocky range of Pacobamba hills into another plain, where there were several cattle and sheep farms; and the

* *Lupinus Paniculatus.* Chloris Andina, ii. p. 252.

village of Corruarini, consisting of a ruined church and a dozen huts. The river Azangaro rises in the snowy mountains of Caravaya, forms an immense curve of nearly half a circle in a course of about two hundred miles, and, uniting with the river of Pucara, falls into the lake of Titicaca as the river Ramiz, the largest of its affluents. After a ride of six leagues we reached the little village of San José, under a conical hill, and close to the snowy mountains of Surapana.

From San José the path winds up a long ravine for several leagues, down which a torrent dashes furiously over the rocks, descending from the snowy peak of Accosiri. The mountain scenery, consisting of steep grassy slopes, masses of rock, torrents, and distant snowy peaks, was very fine. The ravine led up to the summit of the pass of Surupana, where it was intensely cold, and the height of which I roughly estimated, with a boiling-point thermometer, at 16,700 feet above the sea. Here I met an active young vicuña-hunter, well mounted, and provided with a gun, who said he was a servant of the Cacique Chuquihuanca of Azangaro, on his way to buy wool in Caravaya. He continued in my company during most of the day. Loud claps of thunder burst out in different directions, and a snow-storm was drifting in our faces. The ravines were covered with deep snow, between high dark mountains, with abrupt cliffs cropping out. A flock of vicuñas dashed across our path, disappearing again in the driving sleet. After wading through snow and mud for several leagues the weather cleared up, and we began to descend a splendid

gorge, exactly like some of the finest combes on the north coast of Devon, on a gigantic scale. This led us down into a valley, where I parted with my young vicuña-hunter, who had been a very pleasant companion. Riding down the grassy valley, and passing many flocks of sheep, I rode through the village of Potoni, a dozen huts on the side of a hill; forded the river Azangaro, which is here but a small stream even in the rainy season; and riding up the opposite bank, got a magnificent view of the snowy mountains of Caravaya, with their sharp needle-like peaks. Two leagues brought me to Crucero, the capital of the province of Caravaya, so called from the cross-roads which here branch off to the various villages in the forests on the other side of the snowy barrier which rises up close to the town, to the eastward.

Crucero is a collection of comfortless mud-houses, with a small dilapidated church in the plaza, on a very elevated swampy plain. It was intensely cold, with heavy snow-storms during the nights, and the people sat wrapped up in cloaks without fires, shivering in a dreary helpless way, and going to bed soon after sunset, as the only comfortable place. I was most kindly received by the Sub-prefect, Don Pablo Pimentel, a veteran soldier, and an official who had served many years at the head of the government in Caravaya, and in Lampa. Dr. Weddell had named a new genus of chinchonaceous plants *Pimentelia*, in honour of the worthy old Sub-prefect, which had pleased him very much. I remained a few days in Crucero, before setting out for the chin-

chona forests in the valleys of Sandia and Tambopata; and during that time I obtained a good deal of information from Don Pablo Pimentel, and from Señor Leefdael the Judge, respecting the province of Caravaya. Don Pablo had travelled over almost every part of it; and I also received much information at Arequipa from Don Agustin Aragon, a former Sub-prefect, who has a large estate in the Caravaya forests.

Puno to Paucar-colla	9	miles.
„ Caracoto	18	„
„ Juliaca	6	„
„ Lampa	21	„
„ Pucara	27	„
„ Azangaro	16	„
„ San José	18	„
„ Crucero	36	„
	151	„

CHAPTER XIV.

THE PERUVIAN PROVINCE OF CARAVAYA. THE VALLEY OF SANDIA.

THE Peruvian province of Caravaya is drained by streams which form part of the system of the great river Madeira, one of the most important affluents of the Amazon. The Caravayan rivers fall into the Beni, which, with the Mamoré coming from Bolivia, and the Itenez from Brazil, forms the Madeira.

The province of Caravaya consists of a narrow strip of lofty table-land, bordering on that of Azangaro; the snowy range of the Eastern Andes for a distance of 120 miles; and the tropical forests to the eastward, stretching away towards the frontier of Brazil. It is bounded on the east and south by Bolivia, on the north-west by the province of Quispicanchi in the department of Cuzco, on the north and north-east by the tropical forests, and on the west by Azangaro.

The lofty table-land to the westward of the snowy Andes extends for 120 miles, the whole length of Caravaya, but is only from five to ten miles broad. It is 13,000 feet above the level of the sea, and here, about a century ago, the town of Crucero was founded, as a

central position for the capital of the province, and as being free from the attacks of wild Indians. It derives its name from the numerous routes which branch from it to the villages on the eastern slopes of the Andes. This narrow plain, on which Crucero * is situated, is very swampy, covered with long tufts of *ychu* grass, and intensely cold. It yields pasture to immense flocks of sheep; and to the curious hybrid, first bred by the Cura Cabrera in 1826, between an alpaca and a vicuña, called the paco-vicuña, with a black and white fleece of long fine wool, which is wove into fabrics like the richest silk.

On the 18th of April, 1860, I left Crucero, on my way to the chinchona forests, rather late in the afternoon, accompanied by Mr. Weir the gardener, a lad named Pablo Sevallos, and two cargo-mules. After a ride of three leagues along the bleak plain of Crucero, covered with coarse *Stipa* and stunted *Cacti*, we reached a little shepherd's hut, called Choclari-piña, at dusk. It was built of loose stones, with a sheepskin hung across the doorway, but with no plaster or mud between the interstices of the stones, so that the piercingly cold wind blew right through the hut.† The poor Indian family was kind and hospitable, and gave us plenty of fresh milk. Next morning we continued the journey along the same plain, with the snowy peaks of the Caravayan Andes on the left, and the glorious *nevada* of Ananea ahead, where rise the river of Azangaro

* There is one other town, or rather village, on this Arctic plain, within Caravaya, called Macusani, about 30 miles north-west of Crucero.

† The thermometer was at 25° Fahr. inside the hut.

flowing into lake Titicaca, and of Ynambari finding its way to the Atlantic. A ride of twelve miles brought us to a hut called Acco-kunka (neck of sand), at the foot of long ridges of dark-coloured cliffs, with huge boulders of rock scattered over the sides of the hills. A hard white frost covered the ground.

At Acco-kunka I met a red-faced man, about fifty years of age, who gave his name as Don Manuel Martel. He said that he had been a colonel, and had suffered persecution for being faithful to his party; that he had lost much money in the *cascarilla* trade; and that he was now making a clearing in the forests of Caravaya, for the purpose of growing sugar-cane. He talked about M. Hasskarl, the Dutch agent, who was employed to obtain chinchona plants in 1854, under his assumed name of Müller; said that he employed an agent named Clemente Henriquez to collect the plants; and vowed that if he, or any one else, ever again attempted to take *cascarilla* (chinchona) plants out of the country, he would stir up the people to seize them and cut their feet off. There was evidently some allusion to myself in his remarks; and I suspected, what afterwards proved to be the case, that Martel had, by some means, got information respecting the objects of my journey, and was desirous of thwarting them. I had always carefully avoided any mention of the subject since leaving Arequipa. Martel said he was going to buy gold-dust at Poti, so I soon got rid of him; and, passing an alpine lake, full of water-fowl, we began the descent into the golden valleys of Caravaya.

On the left a black cliff, perpendicular, and fully 2000 feet high, formed one side of the descent, and the space on its inner side was occupied by a small glacier, the only one I have ever seen in the Andes; whence descends, in a long waterfall, the source of the little river Huaccuyo, which dashes down the ravine. For the first thousand feet the vegetation continues to be of a lowly alpine character, consisting of coarse grass and flowering herbs, chiefly *Compositæ*, of which there were several *Senecios*, generally with yellow flowers, a gentian with violet-coloured flowers, a *Bartsia* with a yellow flower, a little *Plantago*, and a *Ranunculus*. As we continued the descent, the scenery increased in magnificence. The polished surfaces of the perpendicular cliffs glittered here and there with foaming torrents, some like thin lines of thread, others broader and breaking over rocks, others seeming to burst out of the fleecy clouds; while jagged black peaks, glittering with streaks of snow, pierced the mist which concealed their bases. After descending for some leagues through this glorious scenery, the path at length crossed a ridge, and brought us to the crest of the deep and narrow ravine of Cuyo-cuyo.

The path down the side of the gorge is very precipitous, through a succession of *andeneria*, or terraced gardens, some abandoned, and others planted with ocas (*Oxalis tuberosa*), barley, and potatoes; the upper tiers from six to eight feet wide, but gradually becoming broader. Their walled sides are thickly clothed with Calceolarias, Celsias, Begonias, a large purple Solanum,

and a profusion of ferns. But it was not until reaching the little village in the bottom of the hollow that all the glories of the scene burst upon me. The river of Sandia, which takes its rise at the head of the ravine, flows by the village of Cuyo-cuyo, bordered by ferns and wild flowers. It is faced, near the village, with fern-covered masonry, and is crossed by several stone bridges of a single arch. Almost immediately on either side, the steep precipitous mountains, lined, at least a hundred deep, with well-constructed *andeneria*, and faced with stone, rise up abruptly. In several places a cluster of cottages, built on one of the terraces, seemed almost to be hanging in the air. Above all the dark rocks shoot up into snowy peaks, which stood out against the blue sky. A most lovely scene, but very sad, for the great majority of those carefully constructed terraces, eternal monuments of the beneficence of the Yncas, are now abandoned. The alcalde of Cuyo-cuyo received me most hospitably. In the early morning numbers of lambs and young llamas were playing about in the abandoned terraced gardens near the village. Besides Cuyo-cuyo, there are two small hamlets, called Muchucachi and Sullanqui, and several scattered huts in the ravine, the population of which is estimated at 2000 souls.

In the morning of April 20th I rode down the beautiful gorge to the confluence of the rivers of Sandia and Huaccuyo. After this junction the stream becomes a roaring torrent, dashing over huge rocks, and descending rapidly down the ravine towards Sandia. On both

sides vast masses of dark frowning mountains rear themselves up for thousands of feet, and end in fantastically shaped peaks, some of them veiled by thin fleecy clouds. The vegetation rapidly increased in luxuriance with the descent. At first there were low shrubs, such as *Baccharis odorata, Weinmannia fagaroides,* &c.; which gradually gave place to trees and large bushes; while all the way from Cuyo-cuyo there were masses of ferns of many kinds, Begonias, Calceolarias, Lupins, Salvias, and Celsias. Waterfalls streamed down the mountains in every direction: some in a white sheet of continuous foam for hundreds of feet, finally seeming to plunge into huge beds of ferns and flowers; some like driven spray; and in one place a fall of water could be seen between two peaks, which seemed to fall into the clouds below.

A most glorious and enchanting scene, allowing little time to think of the road, which was very bad, and in many places most perilous. In its best parts it was like a steep back-attic staircase after an earthquake. Three leagues from Cuyo-cuyo is the confluence of the torrent of Ñacorequi with the river of Sandia; and after this point maize begins to be cultivated, where the craggy jutting cliffs permit, between the river and the mountains. The Indians live in eyrie-like huts, perched at great heights, here and there, amongst the maize terraces. The village of Sandia is at a distance of fifteen miles from Cuyo-cuyo, down this ravine, a dilapidated little place, with more than half the houses roofless and in ruins. It is built along the banks of the

river, and has a church in the *plaza*. The mountains rise up all round it, almost perpendicularly, forming a close amphitheatre; and in two places glittering cascades foam down from their very summits, into the bushes on a level with the town.

The descent from the summit of the pass over the Caravayan Andes to Sandia is very considerable, nearly 7000 feet in thirty miles, from an arctic to a sub-tropical climate. The height of Crucero is 12,980 feet; of the pass 13,600; of Cuyo-cuyo 10,510; and of Sandia 6930 feet above the sea.*

The four mountains closely hemming in the village of Sandia are mount Chicanaco, which is beautified by a splendid cascade; mount Vianaco, which ends in two fine wooded peaks, between which a long slender thread of water descends into the foliage midway; mount Camparacani, on the other side of the river, which rises up to a stupendous height, ending in a jagged rocky peak; and mount Catasuyu, which completes the circle, rising abruptly above the church. The name of Sandia is probably a corruption of the Spanish word *sandilla*, the first settlers having mistaken the quantities of gourds which grow here for *sandillas* or water-melons.

When I arrived in Sandia the governor was absent on his estate; the cura, my old friend Dr. Guaycochea, was getting in his maize-harvest on his land near Cuzco; and the principal remaining inhabitants were the Juez de Paz, Don Francisco Farfan, and one Don Manuel Mena, who received me very hospitably. These

* Observations by Negretti and Zambra's boiling-point thermometer.

good people were warm-hearted and neighbourly, and they display some energy in working the coffee and coca estates in the distant montaña, and in making roads, such as they are, from these estates to Sandia. The richer people of Sandia all have more or less of Indian blood, and their wives and daughters are unable to speak any language but Quichua; and thus they seem to be more closely united in interests and feelings with the mass of the population than in any other part of Peru. The Indians of the district of Sandia are divided into six *ayllus* or tribes, besides the inhabitants of the villages of Sandia, Cuyo-cuyo, and Patambuco. These *ayllus* are established on the mountains around Sandia, living in scattered huts, some cultivating maize and potatoes, others raising barley and alfalfa for mules. The *ayllus* are called Laqueque, about a league up the river, on the right bank; Cuyo-cuyo (not the village), behind mount Camparacani; Oruro, on the heights below Cuyo-cuyo; Quiaca (not the village), near Oruro; Quenequi, about a league down the river; and Apabuco, behind mount Catasuyu. The population of the parish of Sandia is about 7000; 4000 in Sandia and its six *ayllus*, 2000 in the village and ravine of Cuyo-cuyo, and 1000 in Patambuco. As many as 1000 souls fell victims to the dreadful pestilence of 1855, which raged over all parts of the Andes of Peru. Nearly every Indian family, besides land near Sandia, owns a small farm of coca or coffee down in the montaña, to which men, women, and children go at harvest-time. As in all ports of the Andes, so in the Sandia ravine, I

constantly found the Indians civil, obliging, and respectful, always saluting with an "Ave Maria Taytay!" and a touch of the hat in passing. They are reserved and silent, it is true, and superficial observers take this for stupidity. Never was there a greater mistake: their skill in carving and all carpenter's work, in painting and embroidery, the exquisite fabrics they weave from vicuña-wool, the really touching poetry of their love-songs and *yaravis*, the traditional histories of their *ayllus*, which they preserve with religious care, surely disprove the charge.

The houses in Sandia are the merest barns, with mud walls, and roofs which let the water in. All the family sleep together in a promiscuous way; pigs and fowls wandering over the floor at early dawn.

My original plan had been to examine the chinchona forests during this month, make as many meteorological and other observations as was possible, and perhaps send down a small collection of plants to the coast; but to make the principal collection in August. I had not, however, been two days in Sandia before I discovered that Martel had already written to several of the inhabitants, urging them to prevent me from taking chinchona plants or seeds out of the country, and to bring the matter before the *Junta Municipal* of the district. I heard also that he was busying himself in the same way in other villages bordering on the chinchona forests. My mission was becoming the talk of the whole country; and I at once saw that my only chance of success was to commence the work of collecting

plants without a moment's delay, and, if possible, anticipate any measures which might be taken to thwart my plans.

It was at Sandia that it became necessary to make final preparations for a journey into the forests, for beyond this point the possibility of procuring supplies of any kind is very doubtful. I here laid in a stock of bread to last for about a month, which was toasted in the oven belonging to the cura, the only one in the place, and which, together with some chocolate and cheese, formed the provisions for myself and the gardener. I then persuaded the judge to order the alcaldes of four of the *ayllus* to procure four Indians and two cargo-mules, the Indians to bring their own provisions with them, for which I advanced them money. After considerable delays my little expedition was ready to start, consisting of myself, Mr. Weir the gardener, Pablo Sevallos the mestizo lad, four Indians, and two mules. The supplies and provisions were packed in six leathern bags, containing tea and sugar, chocolate, toasted bread, cheese, candles, concentrated beef-tea, changes of clothes, instruments, powder and shot, besides a tent, an air-bed, gutta-percha robes, ponchos, a wood-knife and trowel, and maize and salt meat for Pablo and the Indians. It took several days to complete these preparations.

The climate of Sandia, at this time of the year, is exceedingly agreeable, the days being fine and clear until late in the afternoon, and not too hot. The prevailing wind blows up the ravine from the north-

east, being the trade which comes across the vast forest-covered plains of the interior. It is this warm trade-wind which produces a much milder climate and more tropical vegetation in Cuyo-cuyo than in Arequipa, though the former place is three thousand feet higher than the latter. In Sandia, just after sunset, it feels rather chilly, and during the middle of the day the sun is exceedingly hot. Light clouds generally hang about the highest peaks. The variety of most beautiful and graceful ferns on the walls of the houses, and near the banks of the river, is endless.

I had the satisfaction of seeing in the house of Don Manuel Mena, before leaving Sandia, a bundle of small branches of the *ychu cascarilla* (*C. Calisaya*, var. *β Josephiana*), with leaves and flowers, which had been collected as a tonic medicine for a little daughter of my host.

On the 24th of April, late in the afternoon, we left Sandia, and reached the *tambo*, or travellers' hut, called Cahuanchaca, before dark. The road leads down the ravine, along narrow ledges overhanging the river, which dashes furiously along, in most places between perpendicular cliffs. The path is very narrow and dangerous, but the scenery is superb, and the vegetation becomes richer and more tropical at every league of the descent.

One of the Indians deserted on the first day, and my party was thus reduced to three, who were barely able to carry the necessary provisions. These three men proved faithful and willing fellow-labourers. Their

names were Andres Vilca of the Oruro *Ayllu*, Julian Ccuri of Cuyo-cuyo, and Santos Quispi of Apabuco. They were fine-looking young fellows, wearing their hair in long plaits down their backs, coarse canvas trousers and shirts. They carry the cargoes in large cloths tied in bundles, and placed in other cloths, which are passed over one shoulder and tied across the chest, called *ccepis*. They stoop forward and step out at a great rate; and it is in this way that Indians carry their burdens along the roads, and women their children, throughout Peru. The *tambo* of Cahuanchaca is a shed, with one side open, and we slept in company with three Indians and a woman on their way to get in a coca-harvest in the Hatun-yunca, who were living very well on salt mutton, eggs, and potatoes.

The river rushing down the valley winds along the small breadth of level land, striking first against the precipitous cliffs on one side, and then sweeping over to the other, so that a road in the bottom of the valley would require a bridge at almost every hundred yards. It has, therefore, been necessary to excavate a path in the sides of the mountains, high above the river, which in some places has a breadth of three feet only, with a perpendicular cliff on one side, and a precipice six or seven hundred feet deep on the other; while, in others, it zigzags down amongst loose stones, where one false step would be immediate destruction. But the scenery continued to increase in beauty, and the cascades were really splendid:

"A land of streams! some, like a downward smoke,
Slow-dropping veils of thinnest lawn, did go;
And some thro' wavering lights and shadows broke,
Rolling a slumbrous sheet of foam below."

The river dashed noisily through the centre of the gorge, and the masses of green on either side were toned down by many flowers in large patches, bright purple *Lasiandræ*, orange *Cassiæ*, and scarlet *Salviæ*. I also saw an *Indigofera* growing in this part of the ravine.

A mile from the hut of Cahuan-chaca is the confluence of the river Huascaray; and a league lower down is the little shed or tambo of Cancallani. Here bamboos and tree-ferns first appear, and coca is cultivated in terraces which are fringed with coffee-plants, with their rich green foliage and crimson berries. I observed that the huts in the middle of these patches of coca or maize had no doors, showing the confidence of the inmates in the honesty of the numerous passers-by, who go to and fro between Sandia and the more distant coca estates.* I passed the estate of Chaylla-

* The same was once the case all over Peru, in the good old days of the Yncas, as we know from the curious dying confession of the last of the conquerors, Marcio Serra de Lejesama, addressed to Philip II., A.D. 1589.

"Your Majesty must understand that my reason for making this statement is to relieve my conscience, for we have destroyed the government of this people by our bad example. Crimes were once so little known among them that an Indian with 100,000 pieces of gold and silver in his house left it open, only placing a little stick across the door, as a sign that the master was out, and nobody went in. But when they saw that we placed locks in our doors, they understood that it was from fear of theft; and when they saw that we had thieves amongst us, they thought little of us; but now these natives, through our bad example, have come to such a pass that no crime is unknown to them."—*Calancha*, lib. i. cap. 15, p. 98.

bamba, with terraces of coca at least fifty deep, up the sides of the mountains; and Asalay, a coffee estate, with groves of orange and chirimoya-trees. At the confluence of the rivers Asalay and Sandia perpendicular cliffs rise abruptly from the valley to a stupendous height on both sides, and the path winds up in a serpentine slippery staircase, to creep along the edge of the steep grassy slopes or *pajonales*, far above the tropical vegetation of the ravine. Winding along this path, we came to the *tambo* of Paccay-samana, on the grassy *pajonal*, the mountains rising up on the opposite side of the ravine only about sixty yards distant; yet the river, in the bottom of the gorge, was many hundreds of feet below. There were thickets with masses of bright flowers in the gullies, and glorious cascades shimmering in the sunlight on the opposite mountain-sides.

It was at this spot that we first encountered chinchona-plants. A number of young plants of *C. Calisaya*, var. *β Josephiana*, were growing by the side of the road, with their exquisite roseate flowers, and rich green leaves with crimson veins. The rock is a metamorphic slate, unfossiliferous, slightly micaceous, and ferruginous, with quartz occurring here and there: the soil a stiff brown loam. Above the tambo there was a small thicket of gaultherias, called *ccarani* in Quichua, and Melastomaceæ with bright purple flowers (*Lasiandra Fontanesiana*), in a shallow gully, surrounded by the rich broad-bladed grass of the *pajonal*. Here there were some fine plants of the chinchona named by

Dr. Weddell *C. Caravayensis;* and further on more plants of *C. Josephiana,* called *ychu cascarilla* by the natives. The height of the spot is 5420 feet above the sea. A tree-fern and many *Trichomanes* were growing with the chinchonæ. Paccay-samana is sixteen miles from Sandia.

Animal life did not appear to be very abundant. There were plenty of large doves, some ducks near the river, and a brilliant woodpecker. I also saw great numbers of large swallow-tailed butterflies, purple with light-blue spots on the upper wings; and others with white upper wings edged with jet-black and rows of white spots, the lower wings orange.

Beyond Paccay-samana there were several more plants of *C. Josephiana* rising out of masses of maiden-hair and *Polypodia.* After following the edge of the pajonal for about a mile, we descended by a precipitous zigzag path and crossed over the river Pulluma, at its confluence with the Sandia. Here the road to the Hatun-yunca or Valle Grande branches off up the mountain of Ramas-pata, while our way continued down the ravine. The scenery is here remarkably beautiful. Lofty mountains, with their bright cascades, are clothed to their summits with rich grass, while their gullies are filled with flowering trees and shrubs. Halfway up, in many directions, the stone terraces of coca rise tier above tier, fringed with ferns and begonias, and filled with the delicate coloured green coca-branches, diversified occasionally by the darker hues of the coffee. The ravine is filled with masses of purple Melastomaceæ,

and the river is fringed with tree-ferns, plantains, and bamboos.

This purple Melastomacea (*Lasiandra Fontanesiana*), called in Quichua *panti-panti*, in the brilliancy and abundance of its flowers, bears the same relation to this part of the Peruvian Andes as the rhododendron does to the Himalayas. The effect in masses is much the same, but the *Lasiandra* appears to me to be a more graceful and delicate tree, with a more beautiful flower. In this ravine we have the shrub chinchonæ on the high grassy slopes, perhaps the finest coffee in the world near the banks of the river, and a little galium by the road-side—all chinchonaceous plants.

At noon on April 26th we rested in the tambo of Ypara, in the centre of coca cultivation, and in the afternoon, crossing the river by a wooden bridge, we had to travel along the skirts of the mountains, at a considerable height, in the region of the *pajonales*. No gullies or large cascades cut up the face of these mountains, which were entirely exposed to the full glare of the sun, and here, though there was a profusion of purple Melastomaceæ in some of the shallow indentations, there were no chinchonæ. Towards evening we came to a lofty spur of the mountain, called Estanqui, at a great height above the ravine, whence there was a most extensive view. To the left was the valley of Sandia, with little coca-farms nestling in all the sheltered gullies; and I could just make out the boys and girls far, far below, like specks, busy with the coca-leaves in the drying-yards. In front there was a distant view of

the hills in the direction of San Juan del Oro, covered with virgin forest; while at our feet, and a thousand feet below us, was the confluence of the rivers Sandia, Llaypuni, and Huari-huari, which unite to form the great river Ynambari.

It was my intention, after marking down all the eligible plants of the shrubby *Calisaya*, to be taken up on our return, to make for the forest-covered valley of Tambopata, which is full of chinchona trees; and I therefore left the ravine of the Sandia river at this point, and, by a rapid descent, went down from the grassy uplands to a region of tropical forest, full of palms and tree-ferns. We thus reached the banks of the Huari-huari. This river flows through a deep and very narrow ravine, lined with forest for about 500 feet, above which rise grassy mountains to an immense height. Though only 30 feet across, and confined by dark polished rocks, the Huari-huari is very deep, and decidedly a more important stream than the Sandia, at their junction.

We established ourselves under a rock, where there was no room to pitch the tent, and thus our first night of camping out commenced, for previously we had slept in the road-side *tambos*. The Indians carried little earthen pots for cooking, in their *ccepis*, and got up a fire of dry sticks with great rapidity. I had a delicious bath in the river, where the tall forest trees overshadowed the water on either side. At night the moon streamed its floods of light over the forest, and the brilliant sparks from myriads of fire-flies shone from the trees in every direction up the side of the opposite mountain; but in

the early morning the sky clouded over, and a heavy drizzling rain began to fall, which prevented sleep, and made us wish for day.

From this encampment our way led up the precipitous sides of the mountain, to the grassy *pajonales* which divide the valleys of Sandia and Tambopata; but I will here halt awhile to give a brief account of the cultivation of that plant, of which we had lately seen so much, and which enabled me to ascend the mighty passes of the Andes on foot with ease and comfort—the strength-giving, invigorating coca.

During my stay at Sandia the indications of the thermometer were as follow, between the 20th and 25th of April:—

Mean temperature . . .	$63\frac{1}{5}^{\circ}$
Minimum temperature at night .	$50\frac{1}{2}$
Highest observed . . .	65
Lowest	47
Range	18

CHAPTER XV.

COCA CULTIVATION.

THE coca-leaf is the great source of comfort and enjoyment to the Peruvian Indian; it is to him what betel is to the Hindu, kava to the South Sea Islander, and tobacco to the rest of mankind; but its use produces invigorating effects which are not possessed by the other stimulants. From the most ancient times the Peruvians have used this beloved leaf, and they still look upon it with feelings of superstitious veneration. In the time of the Yncas it was sacrificed to the Sun, the Huillac Umu or high priest chewing the leaf during the ceremony; and, before the arrival of the Spaniards, it was used, as the cacao in Mexico, instead of money. After the conquest, although its virtues were extolled by the Ynca Garcilasso de la Vega,* and by the Jesuit Acosta,† some fanatics proposed to proscribe its use, and to root up the plants, because they had been used in the ancient superstitions, and because its cultivation took away the Indians from other work. The second Council of Lima, consisting of bishops from all parts of South

* G. de la Vega, *Com. Real.* i. lib. viii. cap. 15.

† *Acosta*, lib. iv. cap. 22, who cannot agree with those who believe its reputed virtues to be the effects of imagination.

America, condemned the use of coca in 1569 because it was a "useless and pernicious leaf, and on account of the belief stated to be entertained by the Indians that the habit of chewing coca gave them strength, which is an illusion of the devil."*

In speaking of the strength the coca gives to those who chew it, Garcilasso de la Vega relates the following anecdote. "I remember a story which I heard in my native land of Peru, of a gentleman of rank and honour named Rodrigo Pantoja, who, travelling from Cuzco to Rimac (Lima), met a poor Spaniard (for there are poor people there as well as here) who was going on foot, with a little girl aged two years on his back. The man was known to Pantoja, and they thus conversed. 'Why do you go laden thus?' said the knight. The poor man answered that he was unable to hire an Indian to carry the child, and for that reason he carried it himself. While he spoke Pantoja looked in his mouth, and saw that it was full of coca; and, as the Spaniards abominate all that the Indians eat and drink, as though it savoured of idolatry, particularly the chewing of coca, which seems to them a low and vile habit, he said, 'It may be as you say, but why do you eat coca like an Indian, a thing so hateful to Spaniards?' The man answered, 'In truth, my lord, I detest it as much as any one, but necessity obliges me to imitate the Indians, and keep coca in my mouth; for I would have you to know that, if I did not do so, I could not carry this burden; while the coca gives me sufficient strength to endure the

* *Cedula*, 18 Oct. 1569.

fatigue.' Pantoja was astonished to hear this, and told the story wherever he went; and from that time credit was given to the Indians for using coca from necessity, and not from vicious gluttony."

The Spanish Government interfered with the cultivation from more worthy motives, and *mitas* of Indians, for the purpose of collecting coca-leaves, were forbidden in 1569, owing to the reputed unhealthiness of the valleys.* Finally, Don Francisco Toledo, Viceroy of Peru, permitted the cultivation with voluntary labour, on condition that the Indians were well paid, and that care was taken of their health. This most prolific of Peruvian legislators issued no less than seventy *ordenanzas* on this subject alone, between the years 1570 and 1574. Coca has always been one of the most valuable articles of commerce in Peru, and it is used by about 8,000,000 of the human race.

The coca plant (*Erythoxylon coca*) † is cultivated between 5000 and 6000 feet above the level of the sea, in the warm valleys of the eastern slopes of the Andes, where almost the only variation of climate is from wet to dry, where frost is unknown, and where it rains more or less every month in the year. It is a shrub from four to six feet high, with lichens, called *lacco* in Quichua, usually growing on the older trunks. The

* *Solorzano, Polit. Ind.*, lib. ii. cap. 10, quoted by Unanue.

† J. de Jussieu was the first botanist who sent specimens of coca to Europe, in 1750.

Dr. Weddell suggests that the word comes from the Aymara *khoka*, a tree, i.e. *the* tree *par excellence*, like *yerba*, *the* plant of Paraguay. The Ynca historian Garcilasso, however, spells the word *cuca*.

branches are straight and alternate; leaves alternate and entire, in form and size like tea-leaves; flowers solitary with a small yellowish-white corolla in five petals, ten filaments the length of the corolla, anthers heart-shaped, and three pistils.

Sowing is commenced in December and January, when the rains begin, which continue until April. The seeds are spread on the surface of the soil in a small nursery or raising ground called *almaciga*, over which there is generally a thatch roof (*huasichi*). At the end of about a fortnight they come up; the young plants being continually watered, and protected from the sun by the *huasichi*. The following year they are transplanted to a soil specially prepared by thorough weeding and breaking up the clods very fine by hand; often in terraces only affording room for a single row of plants, up the sides of the mountains, which are kept up by small stone walls. The plants are generally placed in square holes called *aspi*, a foot deep, with stones on the sides to prevent the earth from falling in. Three or four are planted in each hole, and grow up together. In Caravaya and Bolivia the soil in which the coca grows is composed of a blackish clay, resulting from the decomposition of the schists, which form the principal geological features of the mountains. On level ground the plants are placed in furrows called *uachos*, separated by little walls of earth (*umachas*), at the foot of each of which a row of plants is placed; but this is a modern innovation, the terrace cultivation being the most ancient. At the end of eighteen

months the plants yield their first harvest, and continue to yield for upwards of forty years. The first harvest is called *quita calzon*, and the leaves are then picked very carefully, one by one, to avoid disturbing the roots of the young tender plants. The following harvests are called *mitta* ("time" or "season"), and take place three times, and even four times, in the year. The most abundant harvest takes place in March, immediately after the rains; the worst at the end of June, called the *mitta de San Juan*. The third, called *mitta de Santos*, is in October or November. With plenty of watering, forty days suffice to cover the plants with leaves afresh. It is necessary to weed the ground very carefully, especially while the plants are young, and the harvest is gathered by women and children.

The green leaves, called *matu*, are deposited in a piece of cloth which each picker carries, and are then spread out in the drying-yard, called *matu-cancha*, and carefully dried in the sun. The dried leaf is called *coca*. The drying-yard is formed of slate-flags, called *pizarra;* and when the leaves are thoroughly dry, they are sewn up in *cestos* or sacks made of banana-leaves, of twenty pounds each, strengthened by an exterior covering of *bayeta* or cloth.* They are also packed in *tambores* of fifty pounds each, pressed tightly down. Dr. Poeppig reckoned the profits of a coca-farm to be forty-five per cent.

* The cesto of coca sold at eight dollars in Sandia. In Huanuco it was five dollars the arroba of 25 lbs.

The harvest is greatest in a hot moist situation; but the leaf generally considered the best flavoured by consumers, grows in drier parts, on the sides of hills. The greatest care is required in the drying; for too much sun causes the leaves to dry up and lose their flavour, while, if packed up moist, they become fetid. They are generally exposed to the sun in thin layers.

Acosta says that in his time the trade in coca at Potosi was worth 500,000 dollars annually; and that in 1583 the Indians consumed 100,000 *cestos* of coca, worth 2½ dollars each in Cuzco, and 4 dollars in Potosi. In 1591 * an excise of 5 per cent. was imposed on coca; and in the years 1746 and 1750 this duty yielded 800 and 500 dollars respectively, from Caravaya alone. Between 1785 and 1795 the coca traffic was calculated at 1,207,430 dollars in the Peruvian viceroyalty; and including that of Buenos Ayres, 2,641,487 dollars.

In the district of Sandia, in Caravaya, there are two kinds of coca, that of Ypara and that of Hatun-yunca, which has a larger leaf. The yield is 45,000 cestos a year. In the yungus of La Paz, in Bolivia, the yield is about 400,000 cestos. The coca-trade is a government monopoly in Bolivia, the state reserving the right of purchasing from the grower, and reselling to the consumer. This right is generally farmed out to the highest bidder. In 1850 the coca duty yielded 200,000 dollars to the Bolivian revenue.

The approximate annual produce of coca in Peru is

* Report of the Prince of Esquilache.

about 15,000,000 lbs.,* the average yield being about 800 lbs. an acre. More than 10,000,000 lbs. are produced annually in Bolivia, according to Dr. Booth of La Paz; so that the annual yield of coca throughout South America, including Peru, Bolivia, Ecuador, and Pasto, may be estimated at more than 30,000,000 lbs. At Tacna the *tambor* of 50 lbs. is worth 9 to 12 dollars, the fluctuations in price being caused by the perishable nature of the article, which cannot be kept in stock for any length of time. The average duration of coca in a sound state, on the coast, is about five months, after which time it is said to lose flavour, and is rejected by the Indians as worthless.

The reliance on the extraordinary virtues of the coca-leaf, amongst the Peruvian Indians, is so strong that, in the Huanuco province, they believe that, if a dying man can taste a leaf placed on his tongue, it is a sure sign of his future happiness.†

No Indian is without his *chuspa* or coca-bag, made of llama-cloth dyed red and blue in patterns, with woollen tassels hanging from it. He carries it over one shoulder, suspended at his side; and, in taking coca, he sits down, puts his *chuspa* before him, and places the leaves in his mouth one by one, chewing and turning them till he forms a ball. He then applies a small quantity of carbonate of potash, prepared by burning the stalk of the quinoa plant, and mixing the ashes with lime and water; thus forming cakes called *llipta*, which

* Poeppig calculated the yield of Huanuco at 500,000 lbs.

† Poeppig, *Reise*, ii. p. 252; also Von Tschudi, p. 455.

are dried for use, and also kept in the *chuspa*.* This operation is called *acullicar* in Bolivia and Southern Peru, and *chacchar* in the North. They usually perform it three times in a day's work, and every Indian consumes two or three ounces of coca daily.

In the mines of the cold region of the Andes the Indians derive great enjoyment from the use of coca; the running *chasqui*, or messenger, in his long journeys over the mountains and deserts, and the shepherd watching his flock on the lofty plains, has no other nourishment than is afforded by his *chuspa* of coca, and a little maize. The smell of the leaf is agreeable and aromatic, and when chewed it gives out a grateful fragrance, accompanied by a slight irritation, which excites the saliva. Its properties are to enable a greater amount of fatigue to be borne with less nourishment, and to prevent the occurrence of difficulty of respiration in ascending steep mountain-sides. Tea made from the leaves has much the taste of green tea, and, if taken at night, is much more effectual in keeping people awake. Applied externally coca moderates the rheumatic pains caused by cold, and cures headaches. When used to excess it is, like everything else, prejudicial to the health, yet, of all the narcotics used by man, coca is the least injurious, and the most soothing and invigorating.

The active principle of the coca-leaf was separated

* In Caravaya the *llipta* is made into a pointed lump and kept in a horn, or sometimes in a silver receptacle, in the *chuspa*. With it there is also a pointed instrument, with which the *llipta* is scratched, and the powder is applied to the pellet of coca-leaves. In some provinces they keep a small calabash full of lime in their *chuspas*, called *iscupurus*.

by Dr. Niemann, and called *cocaine*. Pure *cocaine* crystallises with difficulty, is but slightly soluble in water, but is easily dissolved in alcohol, and still more easily in ether.*

I chewed coca, not constantly, but very frequently, from the day of my departure from Sandia, and, besides the agreeable soothing feeling it produced, I found that I could endure long abstinence from food with less inconvenience than I should otherwise have felt, and it enabled me to ascend precipitous mountain-sides with a feeling of lightness and elasticity, and without losing breath. This latter quality ought to recommend its use to members of the Alpine Club, and to walking tourists in general, though the sea voyage probably causes the leaves to lose much of their virtue. To the Peruvian Indian, however, who can procure it within a few weeks of its being picked, the coca is a solace which is easily procured, which affords great enjoyment, and which has a most beneficial effect.†

* *Bonplandia*, viii. p. 355–78.

† The information in this chapter is derived from personal observation; from the essay on coca by Dr. Don Hipolito Unanue, in Nos. 3 to 8 of the *Museo Erudito*; and from the works treating of coca, by Von Tschudi, *Travels in Peru*, p. 455; Dr. Poeppig, *Reise in Peru*, ii. p. 248; Dr. Weddell, *Voyage dans le Nord de Bolivie*, p. 516; the *Bonplandia*; and a memorandum by Dr. Booth, of La Paz. These are the best authorities on the subject.

CHAPTER XVI.

CARAVAYA.

CHINCHONA FORESTS OF TAMBOPATA.

ON the morning of April 27th we crossed a rude bridge over the Huari-huari, and began to make our way up the face of the steep mountain on the other side, first through a thick forest, and then up into the grassy highlands, until, after several halts, we at length reached the summit of the ridge, though a mountain-peak still rose up in our rear. From this point there was a most extensive panoramic view. A sea of ridges rose one behind the other, with stupendous snowy peaks in the background, and, more than a thousand feet below, the rivers of Sandia and Huari-huari, reduced to mere glittering threads, could be seen winding through the tortuous ravines. We had now reached the *pajonales*, and were on a ridge or backbone between the rivers of Laccani and San Lorenzo, two tributaries of the Huari-huari; a grass-covered and comparatively cold region, interspersed with thickets, forming the crest of the tropical forests which line the sides of the ravines through which the rivers wind, far below.

When there is sunshine, these *pajonales* form a very

pleasant landscape: the broad expanse of grass, dotted over with a graceful milk-white flower called *sayri-sayri*, is intersected by dense thickets, some in the gullies and watercourses, and others in clumps, like those in an English park, the palms and tree-ferns raising their graceful heads above the rest of the trees. Here and there a black pool of sweet water is met with at the edge of the thicket, with chinchona and *huaturu* trees drooping over it. Everywhere there is an abrupt boundary to the foreground in the profound forest-covered ravines, with splendid views of mountain ranges in the distance.

The vegetation of the thickets in these *pajonales* consists of *palms*, *tree-ferns*, *Melastomaceæ* (*Lasiandra Fontanesiana*) with bright showy flowers, exceedingly pretty *Ericaceæ* (*Gaultheriæ*), *Vacciniæ*, the *Huaturu* or incense-tree in great quantities, and *Chinchonæ*, chiefly consisting of *C. Caravayensis* (Wedd.), with a few plants of *Calisaya Josephiana*, but the latter are much more rare here than in the neighbourhood of Paccay-samana. The *C. Caravayensis*, a worthless species, has panicles of beautiful deep roseate flowers, large coarse hairy capsules, and lanceolate leaves, above smooth with purple veins, and hairy on the under side. It can probably bear greater cold than any other chinchona.*

The afternoon was passed in searching for plants of the shrubby *Calisaya*, but with little success. During

* Dr. Weddell, the discoverer of this species, had never seen it in flower. I brought home leaves, flowers, and fruit of the *C. Caravayensis*, which are now in the herbarium at Kew.

our examination of the thickets we found a single specimen, evidently belonging to the *Calisaya* species, but in the form of a tree, and not of a shrub. Its height was eighteen feet six inches; its girth, two feet from the ground, eight and a half inches; and the position in which it was growing was 5680 feet above the level of the sea. I was uncertain whether it belonged to the tree variety (*Calisaya vera*, Wedd.), or to the shrub (*Calisaya Josephiana*); for Dr. Weddell only gives the height of the latter at eight or ten feet.

Near the banks of one of the black pools, overhung by spreading branches, we found a shed, a roof of coarse grass raised on four sticks four and a half feet high, and here we encamped for the night. It had been made by some party of incense-collectors from Bolivia, who wander through these wilds. Towards sunset it began to pour with rain, and continued through the night.

From this point to the Tambopata valley the road was unknown to my Indians, and had not been traversed since the time of the bark trade, which came to an end fifteen years ago. It was supposed that any path which might once have existed would be entirely choked up by the forest, and I therefore started early in the morning, with Andres Vilca, to reconnoitre. The backbone of the ridge along which we travelled was not level, but up and down like a saw, and very rough work. After walking for a league the ridge ended where a transverse range of hills, at a lower elevation, connects the mountains on the further sides of the rivers of San Lorenzo and Laccani, and, closing up the

ravines, contains their sources. This range, at right angles with the one over which we had journeyed, is called the *Marun-kunka*, and is covered with dense forests. It was necessary to force our way through this formidable obstruction, and we plunged into it at once. Our progress was vigorously opposed by closely matted fallen bamboos for the first few hundred yards, and afterwards we followed the course of the torrent, deeply cut in the rock, and forming a passage four to six feet deep, and about three feet across, with masses of ferns and the roots of enormous forest-trees interlacing across overhead, and two feet of exceedingly tenacious yellow mud underfoot. In many places it was almost dark at midday, while in others the rays of the sun succeeded in forcing their way through the ferns, and throwing a pale light across the otherwise gloomy passage. It was a weird unearthly scene. After several hours of very laborious travelling we at length forced our way across the Marun-kunka, and came out upon another *pajonal*, on the eastern side, whence there was a grand view of the forest scenery towards Tambopata, and the snowy peaks of the cordillera above Quiaca and Sina to the right.

The afternoon was again devoted to searching for plants of *Calisaya Josephiana* in the thickets; where the *C. Caravayensis* was very plentiful, together with several plants of the shrubby *Calisaya*, and four or five trees of the normal tree *Calisaya*, from 20 to 30 feet high. The elevation of this place was 5600 feet above the sea. Later in the day the journey was continued

across a most difficult country, sometimes over grassy *pajonales*, and at others painfully struggling through forests like those on the Marun-kunka. In one of these forests I came upon a *Calisaya* tree, 38 feet high, and 1 foot 3 inches in girth at a distance of 3 feet from the ground, which was several feet deep in dead leaves, chiefly the smooth leathery leaf of the *huaturu* tree. At length we commenced the descent into the valley of Tambopata, 1200 feet down slippery rocks and grass, then through a belt of forest, until we suddenly emerged on an open space on the banks of the large rapid river, where there was a bamboo hut. A little coca and sugar-cane was planted, but the occupant was absent. With touching confidence he had left his door open, so my Indians established themselves comfortably, while Weir and I pitched the tent.

The river of Tambopata, descending from the farm of Saqui near the frontier of Bolivia, here flows in a northerly direction. Up the stream I could see a few little clearings, but looking down nothing appeared but the virgin forest. A most magnificent range of mountains, with a fine growth of forest trees, rises up on either side, and the rapid swollen river rushed through the centre of the ravine. The rock of all the ranges of hills between the Huari-huari and Tambopata rivers is a yellow clay-slate, with masses of white quartz cropping out on the *pajonales*.

Early in the morning we continued our journey down the valley, through a forest of grand timber, passing the little hut of Tambopata which Dr. Weddell

had mentioned to me as having been the great rendezvous for *cascarilleros* or chinchona-bark collectors, at the time of his visit. After wading across the rapid little river of Llami-llami, which enters the Tambopata on the left bank, we came to a small clearing, planted with sugar-cane, the property of a very energetic and obliging old Bolivian, named Don Juan de la Cruz Gironda. He was living in a shed, open on two sides, and with a young son, and two or three Indians, was actively clearing, planting sugar-cane, and making rum in an extemporised distillery of his own manufacture. This little farm was the extreme outpost of civilisation in this direction, and had only been commenced since December 1859.

Gironda was cultivating sugar-cane, maize, and edible roots; and, at the time of my visit, he was just commencing his *michca,* or small sowing of maize. His people were driving holes in the ground with long poles, about a foot deep, into which they drop four to six grains, and cover over. The holes are four feet apart, for here the maize grows to an immense height. The agricultural tools were of a most primitive kind. The ground was first broken and cleared with a bit of old iron, fastened, at an acute angle, on a short handle. It was further broken up by an attempt at a spade, an oblong piece of iron, bent at one end round a long pole. The weeds and brushwood were cleared away by an instrument like the first, only turned a different way, both being secured to their handles by leathern thongs. They reaped with the blade of an old knife, and where

the clods required to be broken up very fine, as in coca plantations, it was done by hand. The only use that Gironda put his small supply of sugar-cane to, was making spirits and a small quantity of treacle. The cane was expressed by a very primitive mill of three upright rollers of hard wood, worked by a single capstan-bar and a mule, the juice flowing into a gutter, and running thence, through a bamboo, into a large jar. The juice was then placed in two long canoes, hollow trunks of trees, where it was allowed to ferment. In about eight days the fermentation was over, and it was ready for distilling. This sugar-beer is called *huarapu*, and is rather good. The juice was then poured into a large jar, over an oven, and above the mouth of this jar he placed the broken side of another smaller one, covering the joining round with mud. From the mouth of the second jar a bamboo was led through a large canoe to the mouth of a third jar. The fire was lighted in the oven, the canoe was filled with cold water to condense the vapour as it came up through the bamboo, and the work of distilling began; the clear colourless rum soon commencing to flow out of the bamboo into the receiving-jar. The sugar-cane is of the purplish-brown kind, which is said to ripen quickest.

Gironda also raised a few edible roots, such as *yucas* (*Jatropha Manihot*), *aracachas* * (*Conium moschatum*), *camotes* or sweet potatoes, and *ocas*. He gave me the following information respecting the climate and

* An Umbellifer. The roots taste something like a parsnip, and there are four kinds—white, yellow, brown, and reddish.

seasons in the valley of Tambopata, which is worthy of attention, as this is the very centre of the *C. Calisaya* region.

January.—Incessant rain, with damp heat day and night. Sun never seen. Fruits ripen.

February.—Incessant rain and very hot. Sun never seen. A coca harvest.

March.—Less rain, hot days and nights, little sun. Bananas yield most during the rainy season.

April.—Less rain; hot, humid nights, and little sun in the daytime.

May.—A showery month, but little heavy rain. This is the month for planting coca and sugar-cane, and what is called the *michca*, or small sowing of maize, as well as yucas, aracachas, camotes, and other edible roots. Coffee harvest begins.

June.—A dry hot month. Much sun and little rain. Coca harvest early in the month. Oranges and paccays ripen. Cool nights, but a fierce heat during the day.

July.—The hottest and driest month, but with cool nights. Very few showers. Time for sowing gourds, pumpkins, and water-melons.

August.—Generally dry. Trees begin to bud. A month for planting.

September.—Rains begin. Time for blossoming of many trees. Coca harvest.

October.—Rains increasing. Maize harvest, and time for the "sembra grande," or great sowing of maize.

November.—Heavy rains. A coca harvest.

December.—Heavy rains. Pumpkins ripen.

The inhabitants of the valley of Tambopata consisted of Gironda, his two little boys, one Victorio Jovi, Villalba, and the *cascarillero* named Martinez. Another *cascarillero*, named Ximenes, had lately died. They lived with their families at a place called Huaccay-churu, about half a mile up the Llami-llami river, where there were a few huts, and a small clearing. Gironda's little farm was the last inhabited spot; beyond was the illimitable virgin forest, stretching away for hundreds, nay, thousands of miles, to the shores of the Atlantic.

This forest had not been traversed since 1847, when the bark trade ceased, and it was quite closed up.

By the desertion of one of my Indians on the day we left Sandia, the other three and Pablo Sevallos were barely able to carry the provisions and other necessaries, so that, on reaching Gironda's clearing, which is called Lenco-huayccu,* I found that I had only sufficient food to last for six days. Gironda himself was little better off, and was living on roots, and *chuñus* or potatoes preserved by being frozen in the loftiest parts of the Andes. I determined, however, to penetrate into the forest, in search of chinchona plants, and to trust to Gironda's kindness to supply me with provisions to enable me to return to Sandia.

I was so fortunate as to secure the services of Mariano Martinez, an experienced *cascarillero*, who had acted as guide to Dr. Weddell, on the occasion of his visit to the valley of Tambopata in 1846. He was thoroughly acquainted with all the different species of chinchona-trees, and, reared from a child in these forest solitudes, he was a most excellent and expert woodman, intelligent, sober, active, and obliging.

On May 1st we prepared to enter the dense entangled forest, where no European had been before, and no human being for upwards of thirteen years, except the Collahuayas and incense-collectors. Our party consisted of seven: the three Indians, Weir, Pablo, Martinez, and myself. The Indians, each with their *chuspas* of

* *Lenco* appears to mean "sticky mud," and *huayccu* is a ravine, in Quichua.

coca, and a *chumpi* or belt round their waists, carried the *ccepis* or bundles of provisions; Pablo bore the tent; and we were all armed with *machetes*, or wood-knives, to clear the way. My people were all dressed in coarse cotton cloth, and I wore a leathern hat, red woollen shirt, fustian trousers, and the indispensable *polccos*, or shoes made of *bayeta* or felt, always used in these forests. We were all mustered and ready to start on the verge of Gironda's clearing, which is surrounded by tall forest trees, with the river rushing noisily past, and the opposite mountains covered to their summits with fine timber, when half a dozen pale-faced men emerged from the tangled thicket in our front. They looked wan and cadaverous, like men risen from the dead, and worn out by long watching and fatigue. They turned out to be Collahuayas, collectors of drugs and incense, who penetrate far into the forests to obtain their wares, and come forth, as we then saw them, looking pale and haggard.

These Collahuayas, called also Chirihuanos on the coast of Peru, Yungeños, and Charasanis, are a very peculiar race. They come from three villages in the forest-covered ravines of the Bolivian province of Larecaja, called Charasani, Consata, and Quirbe; and their knowledge of the virtues of herbs has been handed down from father to son from time immemorial. They traverse the forests of Bolivia and Caravaya collecting their drugs; and then set out as professors of the healing art, to exercise their calling in all parts of America, frequently being two and three years away from their

homes, on these excursions. With their wallets of drugs on their backs, and dressed in black breeches, a red poncho, and broad-brimmed hat, they walk in a direct line from village to village, exercising their calling, and penetrating as far as Quito and Bogotá in one direction, and to the extreme limits of the Argentine Republic in the other. Their ancestors did the same in the time of the Yncas, and Garcilasso de la Vega gives some account of the medical treatment adopted by the ancient Peruvian physicians. They were in the habit of letting blood and purging, they administered the powdered leaf of the *sayri* (tobacco) for headaches, *mulli* (*Schinus molle*) for wounds, and a host of other simple herbs for other ailments. Both Garcilasso* and Acosta† mention their knowledge of the virtues of sarsaparilla, yet it is remarkable that the Collahuayas should never have discovered the febrifugal qualities of chinchona-bark.

We saluted these hard-working physicians, and then entered the forest from which they had just emerged. A short walk brought us to the river Challuma,‡ a tributary of the Tambopata, which we waded across. Martinez told me that this was the extreme point reached by Dr. Weddell, and that he came here to see a tree of *C. micrantha* growing.

Beyond the Challuma there is no road at all, and the really serious forest work began; two hornets stinging me on the temple and back of the neck, as I forced my way through the first bush. Martinez went in front as

* *Com. Real.* i. lib. viii. cap. 15. † Lib. iv. cap. 29.

‡ Not, of course, the famous gold-bearing river of the same name.

pioneer, clearing away obstructions with his *machete*, and the rest of our little party followed. Between lordly trees of great height the ground was entirely choked up with creepers, fallen masses of tangled bamboo, and long tendrils which twisted round our ankles, and tripped us up at every step. Ten miles on open ground is only equal to one over such country as this. In many places we had to scramble through the same dense forest, along the verge of giddy precipices which overhung the river. Often we came upon tracks where a giant of the forest had fallen, bearing all before it, and finally dashing over the cliff into the river below. The Tambopata was boiling and surging over a rocky bed, at times far below us, while at others we took advantage of a short strip of rocky beach to escape the forest. Thus we struggled on until sunset, when we reached a stony beach, and encamped for the night. This had been a most fatiguing march. In some places we were a quarter of an hour forcing and cutting our way through a space of twenty yards, and the halt was most welcome. It was a wild scene as the darkness closed round: the camp-fire and Indians on the beach, the dense gloomy forest close behind, the boiling river in front, and forest-clad mountains rising up on the other side.

From this, the first day of our forest-life, until the 14th of May, being just a fortnight, we were actively engaged in the examination of the chinchona region, and in the collection of plants. As the best way of recording the results of our investigations, I now pro-

pose to give a detailed account of our proceedings from day to day; and, in the following chapter, to recapitulate our observations with special reference to the climate, soil, and general habit of those species of chinchonæ which came immediately under our notice. I owe much to the intelligent assistance of our guide Martinez, who, to great experience in woodcraft, added a lynx eye for a *Calisaya* plant; and it required no little quickness and penetration to distinguish these treasures, amidst the close entanglement of the undergrowth, in the dense forests. Martinez spoke Spanish very imperfectly, and, without a knowledge of Quichua, I should have found much difficulty in conversing with him; but he had a most complete and thorough knowledge of all forest-lore, and was acquainted with the native name of almost every plant, and with the uses to which they were or might be applied.

At dawn the Indians found the marks of a jaguar on the beach close to the tent; and a huge snake wriggled through the fallen trees as we re-entered the forest. The brilliant colours and great variety of butterflies were very striking. I particularly noticed one, bright blue and crimson above, with the underside marked with a pattern, like a vortex drawn by a crowquill on the snow-white ground, edged with deep blue. After struggling through the forest for about a mile we came to the foot of the tremendous precipices, one on either side of the river, which Martinez called Ccasa-sani. That on our (the western) shore rises up perpendicularly from the water to a height which we estimated at 500 feet,

ending in a rocky peak. Its sides are masses of bare polished rock, except in the rear, and in some crevices, where vegetation finds a foothold. Amongst other trees the paccay (*Mimosa Inga*), with its cottony fruit, was drooping over the bubbling waves. The river, surging furiously over and around huge masses of rock, dashed noisily on between the two precipices.

We had to ascend the western precipice of Ccasa-sani by a frightful kind of ladder, formed of ledges in the rock, or half-rotten branches of trees, here and there having to cross a yawning chasm on the fallen stems of tree-ferns rotting from age. Near the summit we had a glorious view of the forest-covered mountains, running up into sharp peaks, with graceful palms rising above the other trees on their crests, and standing out against the sky. Several *Calisaya* trees were growing on the summit, with bunches of young capsules, in company with the leathery-leafed *huaturu*, and the *Aceite de Maria* (*Elœagia Mariæ*, Wedd.). The latter is a tree about thirty feet high, with bark covered with white lichens. Among the numerous ferns the most conspicuous was a very large *Polypodium*, called *calaguala*. Descending the rocks of Ccasa-sani, we had to continue the work of cutting our way through the forest, our passage being opposed by matted entanglements of bamboo, and a *Panicum* with blades, the edges of which cut like a penknife, called *challi-challi*. On many of the trees there were hornets'-nests, globes of mud fixed to the leaves, and covered with the insects. I was inadvertently going to touch one, which was attached to

the back of a large fern-frond, when Martinez, with great dexterity, hurled the plants down the precipice, before the savage creatures were aware of their danger.

We were now in the midst of the chinchona region; and passed several trees of *C. ovata* (*Morada ordinaria*) dan *C. micrantha* (*Verde paltaya*). There were also great quantities of a false chinchona, called by Martinez *Carhua-carhua blanca*. We passed through several large groves of this species, which appeared to be a *Lasionema*, but differed in several respects from the *L. chinchonoides*, mentioned by Dr. Weddell as growing in the Caravayan forests. The tree is very common near the banks of the river Tambopata, frequently with its boughs, large coarse leaves, and panicles of flowers drooping over the water.*

* *Carhua-carhua blanca* (*Lasionema*?)

Tree.—30 or 40 feet high, growing in moist parts of the valley of Tambopata.

Leaves.—Opposite, entire, petiolate, oblong, acute, smooth on both sides, dark green above, lighter beneath, with veins and midrib nearly white; 2½ feet long, by 9 or 10 inches broad. Coarse, bulging, and wrinkled between the veins.

Calyx.—Deep purple and green, leathery, five-toothed, teeth rounded.

Corolla.—Tube white, tinged with light purple, leathery, five laciniæ, smooth and reflexed.

Stamens.—Five, attached to the middle of the tube of the corolla, exserted. Filaments pilose at the base, tinged with purple. Anthers a little shorter than the filaments, all lying on the lower sides of the tube of the corolla, light brown.

Style.—Exserted, but a little shorter than the stamens, light green colour. *Stigma*, bi-eleft.

Panicles.—Corymbose and multiflor, in threes, six to fifteen buds on each. *Pedicels* a brownish purple.

I have attempted to describe this tree because I have been unable to identify it with any of the chinchonaceous plants in Dr. Weddell's work.

The magnitude and variety of the trees of the forest were very striking; and the imposing character of the scenery, in these vast solitudes, was a source of constant enjoyment, and lightened the fatigues of the journey. Among the wonders of the forest there were enormous trees with great buttressed trunks, others sending down rope-like tendrils from the branches in every direction, the gigantic balsam-tree, the india-rubber tree, and many others. A list of the ferns or mosses, endless in the variety of their shape and size, would fill volumes. Of palms, also, there were many kinds. The tall *chonta*, with its hard serviceable wood; the slender beautiful *chinilla* (*Euterpe?*); the towering *muruna* (*Iriartea?*), with its roots shooting out in every direction from eight feet above the ground, and triangular-notched leaflets; the *chaquisapa* (*Astrocaryum?*), with its lofty stem thickly set with alternate rings of spines, and thorny leaves; the *sumballu* (*Guilielma?*), a beautiful palm with a slender stem covered with long sharp spines, numerous graceful leaves, and an edible fruit; and, above all, the *sayal*, the monarch of the palms of these forests, with a rather short thick stem, inner fibres of the stalks like black wool, but with enormous leaves growing rather erect from the stem to a length of at least forty feet—I should think they must be the largest leaves in the whole vegetable kingdom. Among the bright flowers there were crimson *Melastomaceæ*, called *ccesuara*, a scarlet *Justitia*, the *Manettia coccinea*, and many beautiful orchids in the branches of the trees.

At length, after a very hard day's work, we reached

the mouth of the Yana-mayu,* or black river; and attempted to wade across the Tambopata, but found it too powerful. I was particularly anxious to effect this, as Martinez assured me that chinchona-trees were most abundant on the right or eastern bank. We, however, managed to get upon an island, near the left bank, and encamped for the night on a shingly beach. After sunset it came on to rain very heavily, and the waters foamed furiously around us in the inky darkness. The rain continued to pour down, and the waters to rise through the night, and I hourly expected the island to be submerged; but, fortunately, we escaped this danger, though the river came up to within a very few feet of the tent-door. I served out a dram of brandy to all hands.

In the morning of May 3rd I continued my attempts to cross the river, by stripping and trying the water for a ford at several points, with a long pole as a support. But the water was deep, much swollen, and very rapid; and, after having twice been as nearly as possible carried away by the fury of the stream, I was obliged unwillingly to give up the attempt for the present. I considered it prudent also to remove our encampment from the island, and to establish it on a narrow beach overshadowed by the forest, at the point where the muddy waters of the Yana-mayu unite with those of the Tambopata.

These arrangements having been made, we devoted the day to an examination of the adjacent forest. The spot on which we were encamped was about 4600 feet

* *Yana*, in Quichua, is black; and *mayu* a river.

above the sea. Our tent was pitched close to the foaming torrent, and behind rose up the tall dark forests. In front were the steep green sides of the Yana-mayu ravine, while looking down the river the view was bounded by forest-covered mountains, surmounted by the lofty peak of Corimamani. On the actual banks of the river there were trees of *C. micrantha*, with large bunches of lovely and deliciously sweet white flowers; many *carhua-carhua blancas;* and a chinchonaceous tree, which Martinez called *Huiñapu.* The *Huiñapu* grows low down and near the banks of rivers. Its capsules are three inches long; and the veins of the leaves are a pale purple. Dr. Weddell tells me that he recollects gathering the leaves of the *Huiñapu*, and that he took it to be a variety of *Cascarilla magnifolia.*

We commenced the day's work in the forest on the south-west slopes of the Yana-mayu ravine, scrambling up the steep forest-covered declivity amongst palms, tree-ferns, bamboos, and trees with buttressed trunks of stupendous size. Here too were the vast leaves of the *sayal* palm. At a height of 400 feet above the river the *Calisaya* region commences; while in the lower belt, from the river banks to a height of 400 feet, the most abundant chinchonaceous plant is the *Carhua-carhua grande* (*Cascarilla Carua*, Wedd.), with very fragrant white flowers. I met with flowers and capsules together on the same tree, which is forty feet high, with a thick trunk, fine spreading branches, and masses of beautiful white flowers.

I found that the *C. Calisaya* region extended in a belt

from 450 to 650 feet above the banks of the river; bamboos, large palms, *C. micranthas, Huiñapus, Lasionemas*, and the *Cascarilla Carua* being found below that line, and other species of chinchonæ and chinchonaceous plants above it. We collected twenty-five *Calisaya* plants, two of them fine strong seedlings, and the remainder root-shoots springing up from trees which had been cut down by *cascarilleros* in former times, but with good spreading roots of their own. The search was exceedingly hard work, scrambling through matted undergrowth, and up steep ascents, through masses of rotting vegetation.

The afternoon was devoted to an examination of the heights on the north-east side of the Yana-mayu, where, at an elevation of 450 feet, there is a level table-land, covered with palms and bamboos. The search was chiefly conducted along a ridge above this plateau, where the bamboos ended. We obtained twenty more plants of *C. Calisaya*, one of which was declared by Martinez to be a *Calisaya morada* (*C. Boliviana*, Wedd.), and the leaf agreed well with Dr. Weddell's description, though that botanist believed that the species was not found in this part of Caravaya, but only in the valleys of Ayapata, further north. To-day we saw a couple of *tunquis*,* birds with the most gorgeous plumage I ever beheld. They are the size of large pigeons, with orange-scarlet feathers on the head, neck, breast, and tail, black

* *Rupicola Peruviana* (family of *Ampelidæ*). Von Tschudi says that they feed on the seeds of chinchona trees.—*Travels in Peru*, p. 427.

wings, light-grey back, and scarlet crest. They have a shrill, harsh cry. The butterflies and moths were numerous and brilliant, but so tame, and in such swarms, as to be a perfect plague. There was one bright swallow-tail, with blue wings, fringed with crimson. The torments from venomous insects were maddening; especially from a kind of fly which in a moment raised swellings and blood-red lumps all over the hands and face, causing great pain and irritation. During the night it rained heavily, with peals of thunder and vivid flashes of lightning, while the river increased in size and roared past the tent noisily.

The collection of chinchona plants was deposited in a shady place, near the tent, the roots being well covered over with soft moss.

On the morning of May 4th the river was so swollen as to destroy all hopes of crossing it for the present. It frequently changed its colour, on one morning the surging flood being black, on another tolerably clear, and on another a light muddy colour. By these means Martinez could always tell where the rains had been heaviest, and what stream was contributing an unusual freshet to swell the waters of the Tambopata.

I devoted the day to examining the forest on the declivities overhanging the left bank of the Tambopata, and this was by far the most toilsome and dangerous forest journey we had yet made, rendered worse by a comparative want of success. The whole way was along giddy precipices, seeming to hang halfway between the sky and the roaring torrent, with no foot-

hold but decaying leaves, nothing to grasp but rotten branches, every motion a drenching bath from wet leaves, every other step a painful and dangerous slip or fall, besides hornets and endless thorns. Among the latter I was struck by a tree called *itapallu*, with trunk and branches thickly set with thorns, very large leaves, and the fruit in clusters, like bunches of pearls with purple stalks. We met with large pigeons, flocks of green parrots, paroquets, and tunquis. The forest peeps across the river were superb, but it was difficult to enjoy them. Martinez pointed out a small *Asplenium* called *espincu*, which has a sweet taste, and is sometimes chewed by the Indians for want of coca; and the *panchi*, a tall slender malvaceous tree, with large round leaves on spreading branches at the top, and very white wood. It is used by the Chunchos for procuring fire by friction, and the bark, which peels off in long strips, is serviceable for girdles. During this day we came to the largest *Calisaya* we had yet seen, and Martinez operated on the bark to show his dexterity as a cascarillero, which was remarkable.* Our collection only amounted to fourteen plants, among them two fine seedlings of *C. Calisaya*, two of *C. micrantha*, two of *C. ovata*, var. *β rufinervis*, and the remainder root-shoots of *C. Calisaya:* seedlings of the latter species are exceedingly rare. We returned to our camp dead-beat, and drenched to the skin, only to find that my Indians were declaring that they had been

* The bark, leaves, and capsules from this tree are deposited in the herbarium and museum at Kew.

away long enough, that they had no maize or coca left, and that they must return to their homes at once. Our only hope rested upon them, and, if they had deserted, all our plans would have been entirely frustrated. It, however, required no little persuasion and eloquence to induce them to change their minds, and, as they had nothing left to eat, I sent Andres Vilca back to Gironda, to entreat him to supply us with a few chuñus and a little coca. I then appealed to the others, in their own expressive language, not without success, and the evening ended pleasantly. The Indians had built themselves a little shed of palm-leaves near the tent-door, a bright fire was lighted, and its cheery reflection danced on the waves of the noisy flood.

It rained heavily through the night, and in the morning, hearing from Martinez that the varieties of *C. ovata*, the collection of which had been recommended to me by Dr. Weddell, were only found in a zone at a much greater elevation than that of the *C. Calisayas*, I devoted the day to a search in an almost vertical direction, on the north-east side of the Yana-mayu, towards some heights called Pacchani.

Ascending the steep sides of the ravine of Yana-mayu for about two hundred feet, we reached a narrow level shelf covered with ferns and the huge leaves of the *sayal* palm. The locality was very damp and shady, and the *C. micrantha*, *Huiñapu*, and *Cascarilla Carua* were in great abundance. We continued to ascend through the forest which covered the sides of

the steep mountain, for several hours continuously; the footing consisting of decayed leaves and rotten trunks, moss and ferns covering every tree, and all the vegetation intensely humid. At a height of 750 feet above the river we came to some trees of the *beno-beno* (*Pimentelia glomerata*,* Wedd.), with its bright laurel-like leaves and minute capsules; the *C. pubeseens*, called by Martinez *casearilla amarilla*, still only in bud, which was very abundant; and large trees of the *morada naranjada* (*C. ovata*, var. *a vulgaris*, Wedd.). Near this place a troop of about twenty monkeys went chattering along the tops of the trees, and while I was looking at them a huge black hornet rushed up out of the moss and stung me on the chin. These savage creatures make their nests under the earth, and are called *huancoyru*.

After a long and wearisome but fruitless search for young plants of the *zamba morada* (the *β rufinervis* variety of *C. ovata*) in these excessively damp forests, we began the descent again. Nothing struck me so much as the extraordinary variety of forms and shapes in which nature works in these tropical forests. One is amazed to see enormous trees with their gigantic roots separating at least twenty feet above the ground, and forming perfect Gothic arches. In one place a giant of the forest had grown on the edge of a ridge of rock, and the roots had combined with the stone to form a spacious vaulted cave large enough to hold ten men comfortably. Beautiful variegated leaves of

* I brought home a bunch of the capsules, now in the herbarium at Kew.

Colocasiæ, and a scarlet-flowered *Justitia*, with bright purple leaves, united with a profusion of ferns to ornament the opening, while some tree-ferns, and a *chinilla*, the most slender and elegant of the palms of the forest, guarded the entrance. Rays of the sun struggled through a network of bamboos on an opposite bank, and penetrated into the recesses of the cavern. While I gazed on this lovely scene, the plaintive mournful notes of the little "*Alma perdida*" reached me from the boughs of the great tree. This is a small bird of the finch tribe, of which there are two kinds, one black, the other chestnut with black wings. Their loud clear note is peculiarly sad. Such peeps as these into the secret beauties of the innermost forest recesses are rewards for many hours of toil and disappointment.

Late in the evening I returned to the tent dead-tired, sodden and wet to the skin, covered with moss and fungus, bitten all over by mosquitoes, stung by a hornet, and with hands sliced in pieces by the sharp blades of a *Panicum* called *challi-challi*, but with only three plants of the valuable variety of *C. ovata*. It is most provoking that only the seedlings of all the worthless species of Chinchonæ should be in great abundance; the reason is of course connected with the general felling of the trees of valuable species by the cascarilleros, years ago.

There was little rain during the night, and on May 6th we commenced the search of a range of forest on the south-west side of the Yana-mayu ravine, where we found a large supply of plants of *C. Calisaya*. At a height of 500 feet above the river there was a ridge of

rock jutting out from the forest-covered sides of the ravine. In this spot the ground was not nearly so thickly covered with vegetation; there were no palms, tree-ferns, or plants requiring extreme moisture, and young plants received shade from taller trees, while they also enjoyed plenty of sunshine through the spreading branches. The most abundant plants were *Melastomas, huaturus,* and *Panica,* which climb amongst the branches to a height of thirty feet and upwards. These afford but very slight shade, and below there is an undergrowth of ferns, *Colocasiæ,* and young plants. In some places the ground was carpeted with the lovely pink-ribbed leaves of a *Gymnostachium.* In different parts of this ridge we collected 124 young *C. Calisaya* plants, most of them root-shoots, and a few seedlings. There were also two young trees bearing capsules. The *C. Calisaya* plants were all growing out of the moss which covered the rock to a thickness of eight inches or a foot, together with beautiful *Hymenophylla,** but there was scarcely any soil. The roots spread along the face of the rock, which is a metamorphic clay-slate, unfossiliferous, slightly micaceous, and ferruginous;† and is easily broken up into thin layers by the growth of the plants. In this situation the *C. Calisayas* were more numerous than in any other we have yet seen.

* There we also found the *Trichomanes muscoides,* a pretty little fern which, I am informed by Mr. J. Smith, of Kew, though common in the West Indies, was not previously known to be a native of Peru.

† Specimens from this locality were examined and reported upon at 28, Jermyn Street.

Two bears had made themselves a comfortable and very carefully prepared bed on the summit of the ridge, whence there was an extensive bird's-eye view of the windings of the river, and of the forest-covered mountains beyond. On the opposite mountains there were two or three long bare places—tremendous land-slips, not unfrequent occurrences in the forest. There is a sudden crash, when masses of rock, huge trees, and underwood come rushing down in one fell irresistible swoop. A beautiful white *Stephanotis* was climbing over the rocks. We returned to the camp in a heavy fall of rain, after a very severe but successful day's work, and found that both the Indians and ourselves had come to the end of our provisions, and that Andres Vilca had not returned.

On May 7th we rose to find only a few bread-crumbs in the corner of our bag, and, as famine was thus knocking at the door, it became necessary to beat a hasty retreat. The plants were carefully packed in layers of moss, and sown up in two bundles of Russia matting, which we had brought with us, containing about 200 chinchona plants. In the absence of Andres Vilca, Mr. Weir showed much zeal and energy in undertaking to carry one of these bundles, four and a half feet in circumference, over the slippery and dangerous road, in doing which he fell into the river.

On the morning of May 7th, when we commenced our retreat, it was pouring with rain, and the forest was saturated. We had to wade across many little streams falling into the Tambopata. The first, after leaving the

Yana-mayu, was called Churu-bamba, because it empties itself just opposite an island (*churu*, in Quichua). The next stream was *Uma-yuyu*, *uma* being water in Aymara, and *yuyu* a plant with a large cordate dock-like leaf, used in *chupes*. Thus every little stream and hill had received a name from the cascarilleros of former times, from some peculiarity of position or other similar circumstance, which would easily impress it on the memory. What an improvement on the nomenclature in new countries discovered by Englishmen, where we have an endless succession of Jones's rivers, Smith's mountains, and Brown's islands! Near the banks of these streams there are very large snail-shells, and Martinez described the snails as "a large kind of hornets, all made of flesh, which do not sting." He called them *Mamachuru*, or "Mother of the Island."

On reaching the precipice of Ccasa-sani we scrambled along its slippery sides, in the pouring rain, to collect plants of *C. Calisaya*, and obtained twenty-one good ones. They were growing in a similar situation to those above the Yana-mayu, in company with a number of *Aceite de Maria* trees (*Elœagia Mariæ*),* and completely exposed to the sun, without any shade whatever. Passing the precipice, we continued our damp weary journey, Martinez pointing out everything that was noticeable by the way, especially the *palo santo* (*Guaiacum sanctum*), a very tall tree, the stem 60 to 70 feet high, without a branch, with a few short

* Described by Dr. Weddell, in his *Histoire Naturelle des Quinquinas*, in a note under the genus *Pimentelia*.

horizontally spreading branches at the summit, with pinnate leaves. When the bark is cut, a host of stinging ants come forth. There was also a plant, which he called *achira silvestre* (*Canna achira ?*), with a rhizome, and bunches of rank red berries. We passed through groves of paccays (*Mimosa Inga*), a creeping legume with bright flowers, wild coca, many *Lasionemas*, with their large coarse leaves drooping over the river, and a melastomaceous plant with a crimson fruit. After having been nearly carried away by the force of the Challuma river, in wading across it, I reached Gironda's hospitable shed, after a journey of more than thirty miles, in pouring rain.

On May 8th I left Gironda's clearing, with Martinez, in order to examine the forests above the hut of Tambopata, for plants of *C. Calisaya*. Here, in almost exactly a similar ridge of rock to those which proved so prolific of these precious plants on the heights above the Yana-mayu, and on the precipice of Ccasa-sani, I found a number of plants of *Calisaya morada* (*C. Boliviana*, Wedd.), growing out of moss, amongst the rocks, with scarcely any soil. They were overshadowed by numerous trees, called by Martinez "Compadre * de Calisaya" (*Gomphosia chlorantha*, Wedd.), one of the most graceful and beautiful of the chinchonaceous plants, with deliciously sweet flowers. Dr. Weddell exactly describes it as rising without a branch above all the trees of the forest, and then spreading out in the

* In Peru the father of a child is *compadre* to its godfather. It is considered a very close and sacred relationship.

form of a chandelier, and attracting the attention of the traveller from afar. The bark of this tree, with its transverse cracks, can with difficulty be distinguished from that of *C. Calisaya*. Whilst climbing amongst these rocks, I nearly put my hand on a small viper of a venomous kind, 18 inches long, with a black skin marked with yellow rings, edged with white. In the evening we returned to Gironda's clearing at Lenco-huayccu, with eighty-seven chinchona plants, sixteen of Calisaya fina (*C. Calisaya*, var. *a vera*), and sixty-nine of Calisaya morada (*C. Boliviana*, Wedd.).

We found Gironda, on whom we were now entirely dependent for food, very little better off than ourselves. His supplies consisted of maize, yucas, aracachas, chuñus or frozen potatoes, and quispiñas, made of boiled quinua grains dried in the sun, ground, and preserved as little gritty hard lumps. He also had some *achocches*, which are poor watery cucurbitaceous things, squeezed, and served up in chupes. No salt.

Though frequently baffled, and more than once exposed to much risk in making vain attempts, I had never given up my determination to have at least one day's work on the right bank of the Tambopata. For some days the volume of water had been gradually decreasing, but it was still 40 yards across, and rushing with great velocity over a ford which Gironda believed to exist a little below Lenco-huayccu. I stripped and went in, with the stem of a young *chonta* palm as a support, but, on approaching the mid-channel, the water came up above my middle, the large pebbles slipped

and rolled under my feet, and for some time it was with the utmost difficulty that I held my own; but finally we all reached the right bank in safety.

We were rewarded by a very successful day's work. After ascending the steep ravine, through the zone of bamboos, to a height of 400 feet, we reached a ridge of rocks, where we collected 109 good chinchona plants of the *Calisaya morada* species. The leaves of the chinchonæ, and more especially the *Calisaya* species, are invariably perforated by holes in every direction. Much of this mischief is the work of caterpillars, but it may partly be attributed to the effects of drip from the trees which overshadow them. In this forest there were trees of great height, without a branch for a distance of 50 or 60 feet from the ground, which Martinez called *canela*. The inner bark had a strong taste of cinnamon, and they use it to scent and flavour their *huarapu*, or fermented juice of the sugar-cane. On many trees, in the forest, there are immense masses of earth fixed on the trunk, called *cotocuro*. They consist of exceedingly thin layers, one added to another until they are sometimes of an immense size, eight to ten feet high, and three or four feet across. They are made by myriads and myriads of small yellowish lice, which swarm between each thin layer.

In the evening we incurred the same risks in wading across the river again, but arrived without any accident at Gironda's clearing, where we now had a depôt of 436 chinchona plants.

On May 10th I resolved to make a search on the

heights immediately above Lenco-huayccu, called Gloriapata, for the valuable red-nerved variety of *C. ovata.* I first paid a visit to the poor little Indian wife and children of Martinez at Huaccay-churu, in a hut of split bamboos, surrounded by aracachas, yucas, camotes with their white convolvulus flowers, plantains, frijoles or beans, and the *Amarantus caudatus,* which they call *jataccu* and *cuimi,* using the leaves in *chupes.* We then struck right up the steep declivity of Gloriapata, making our way with difficulty through the dense bamboo thickets, which, in spite of their obstinate obstructiveness, make excellent cisterns, and their joints will always afford a good drink of cool water. For some time we followed a pathway made by a herd of peccaries, until it ended at the mouth of a cave which, though low, appeared to be of considerable size. These peccaries come down in herds of thirty or forty to the clearings, during the night, and do much damage amongst the roots. Some are black and white, and others of a leaden colour.

After ascending for several hundred feet we came to trees of *C. pubescens,* which appear to belong to a zone just below, but in contact with the *C. ovatæ.* Their leaves were eaten by a caterpillar, red at both ends, with a horn, red stripe down the back, and red spots on each side, body striped green and yellow. Some hundred feet higher there were large trees of both varieties of *C. ovata,* growing in very moist parts of the forest, where the trees were covered with *Hymenophylla* and dripping moss, the former a sure sign of extreme

humidity. The ground was covered with fallen leaves to a great depth, and there was a good deal of shade. We collected seven plants of *C. ovata*, var. *α vulgaris*, and eleven of *C. ovata*, var. *β rufinervis*, five of which were strong healthy seedlings, the remainder being suckers, with spreading roots of their own. With the *C. ovatæ* grows the *Carhua-carhua chica* (*Cascarilla bullata*, Wedd.).

In descending from these heights I came to a tree which Martinez called *copal*, but the trunk rose to such an extraordinary height, without branches, that I was unable to make out the appearance of the leaves or flowers. The bark was covered with a milk-white fragrant resin, of a nature analogous to *gum thus* or *gum elemi*. The forest also abounds in vegetable and bees' wax, and in many varieties of gums and resins.

On May 11th, as we had now collected a sufficient number of chinchona plants, including those of the shrub *Calisaya* which we intended to take up on our return across the *pajonales*, to fill the Wardian cases at Islay, Mr. Weir began to make up the plants in layers, with plenty of moss between them, ready for sewing up in the Russia matting. Having heard that a young man, a nephew of Gironda's, had planted a *C. Calisaya* in a small clearing a few leagues up the ravine, I went to examine it. The clearing was on a steep declivity sloping down to the river, and had been partly planted with coffee and coca by its solitary occupant. The tree was a *Calisaya morada*, having been a root-shoot twelve inches high when it was planted in January, 1859. It

was seven feet high, six inches and four-tenths in circumference round the trunk, and three feet three inches across the longest branches from one side of the stem to the other. It was growing on the side of a steep hill, quite open to the south, east, and south-east, at the edge of a clearing, while mountains covered with forest rise up close behind it, on the north and west, to a great height. It is planted in a soil consisting of stiff yellowish loam, composed of vegetable matter, mixed with the disintegration of the soft clay slate. This was then the only cultivated chinchona-tree in Peru. In returning to Lenco-huayccu I saw a flock of *Alectors*, large birds analogous to turkeys, and many parrots; and on my arrival I found that Mr. Weir had already made up the chinchona plants, in four Russia-matting bundles, ready to start for Sandia on the following morning.

CHAPTER XVII.

GENERAL REMARKS ON THE CHINCHONA PLANTS OF CARAVAYA.

THE range of my observations in the chinchona forests extended for a distance of forty miles along the western side of the ravine of Tambopata, and one day's journey on the eastern side. This region is covered, with few exceptions, from the banks of the river to the summits of the mountain-peaks, by a dense tropical forest. The formation is everywhere, as I have before said, an unfossiliferous, micaceous, slightly ferruginous, metamorphic clay-slate, with veins of quartz, and the streams all contain more or less gold-dust. When exposed to the weather this clay-slate quickly turns to a sticky yellow mud,* and lower down it is very brittle, and easily breaks off in thin layers. The soil formed by the disintegration of the rock, mixed with decayed vegetable matter, is a heavy yellowish brown loam, but there is very little of it on the rocky sides of the ravine, and no depth of soil except on a few level spaces and gentle slopes near the banks of the river. Mr. Forbes, in speaking of the extensive range of Silurian formation,

* Hence the name *Lenco-huayccu*. *Lenqui* is anything sticky in Quichua, and *huayccu* a ravine.

of which the Tambopata hills form a part, attributes the frequent occurrence of veins of auriferous quartz, usually associated with iron pyrites, to the proximity of granite, whence they have been injected into the Silurian slates. In the cooling and solidification of granite the quartz is the last mineral element to crystallise and become solid, and he suggests that, during the cooling, the consequent expansion due to the crystallisation of the constituents has forced the quartz and gold, still fluid, into the fissures of the neighbouring rocks, and so formed the auriferous quartz veins. These are only developed in the slate rocks, which, when such veins occur, must be at no great distance from granitic eruptions, either visible, or such as may be inferred to exist.*

The chinchona forests which I examined in the Tambopata valley are between lat. 13° and 12° 30′ S. The elevation above the sea, on the banks of the river, is 4200 feet, while the loftiest crests of the mountains which overhang it on either side attain an elevation of about 5000 feet. In the preceding chapter I have given a general idea of the nature of the climate throughout the year, and my stay was too short to enable me to give any more detailed information for most of the months; but I did not fail to take careful observations while I remained in the valley, which will give an accurate idea of the climate during the month of May. During the fourteen first days of May the results were as follows:—

* *Quarterly Journal of the Geological Society*, Feb. 1, 1860, p. 59.

Mean temperature	69⅝° Fahr.	
,, ,, at 7 A.M. . .	68	
,, ,, at 3 P.M. . .	71½	
,, ,, at 9 P.M. . .	69	
Mean minimum in the night . .	62⅞	
Highest temperature observed . .	75	
Lowest ,, ,, . .	56	
Entire range	19	
Mean variation in the 24 hours . .	10⅛	
Greatest ,, ,, . .	15	
Least ,, ,, . .	6	
Mean of the dew-point . . .	61¼	
,, ,, at 7 A.M. . .	61·9	Dry bulb
,, ,, at 3 P.M. . .	62·5	as above.
,, ,, at 9 P.M. . .	60·9	

The wind generally blows up the valley during the daytime, when the clouds ascend, to be condensed by the colder night-air. Thus we almost invariably had rain at night, generally in a heavy fall, but occasionally in small drizzle, which usually continued until the forenoon. At noon it cleared up for a fine afternoon, and only on two occasions did we have rain throughout the day. The valley, and the course of the river, bear N.N.W. and S.S.E.

The three valuable species of chinchonæ found in Tambopata grow in distinct zones as regards elevation, together with other chinchonaceous plants, up the declivitous sides of the ravine.

From the banks of the river to about 400 feet up the mountains, the forest consists of bamboos, several genera of palms, tree-ferns, paccays, and other *Leguminosæ*, *Lasionemas*, *Cascarilla Caruas*, and the *Chinchona micrantha*, together with the chinchonaceous tree called by Martinez *Huiñapu*. This is the lower zone.

The *C. micrantha*, called by Martinez *verde paltaya* and *motosolo*,* was in flower in May. I met with it constantly in moist low places; and several trees, with their very large ovate leaves, and bunches of white fragrant flowers, were actually drooped over the waters of the river. It produces a good quality of bark, and I collected seven fine seedling plants of this species.

From 400 to 600 feet above the river is the middle zone, and that which contains the Calisaya plants. The vegetation chiefly consists of huge balsam and India-rubber trees, *huaturus*, *Melastomaceæ*, Aceite de Maria (*Elœagia Mariæ*), Compadre de Calisaya (*Gomphosia chlorantha*), and occasional trees of *Cascarilla Carua*, which straggle up from the lower zone. Here the young trees of *C. Calisaya* grow in great abundance, but the cascarilleros had certainly done their work well in former years, for every single tree of any size had been felled, though many of the young root-shoots were 20 and 30 feet high, and covered with capsule-bearing panicles. These precious trees were most plentiful under the ridges of rock which crop out at intervals, where the ground was not so thickly covered with vegetation, and where the young plants obtained plenty of light and air, while they were partially protected from the direct rays of the sun by the spreading branches of taller trees. The *Calisaya* trees, on the Ccasa-sani precipice, however, had no shade whatever. They were covered with capsules. I observed that when

* Dr. Weddell believes it to be a distinct species from the *C. micrantha* of Huanuco, and has named it *C. affinis*.

the young plants of *C. Calisaya* grew up the sides of the rocks, and actually came in contact, they often threw out roots from their stems or branches. The *C. Calisaya* is by far the most beautiful tree of these forests. Its leaves are of a dark rich green, smooth and shining, with crimson veins, and a green petiole edged with red, and the deliciously sweet bunches of flowers are white, with rose-coloured laciniæ, edged with white marginal hairs. But it was evident that we did not see them to advantage in these forests; they ran up tall and straggling, as if seeking the sun, and seemed to pant for more light and air, and a deeper and richer soil. Martinez told me that, when the Calisaya is much overshadowed by other trees, it loses the crimson colour on the petioles and veins of the leaves; and that fifteen leagues lower down the river (I suppose at about four thousand feet above the sea) the leaves of the *Calisaya morada* become quite bright purple all over the under side.

Gironda and Martinez told me that there were three kinds of Calisaya trees; namely, the *Calisaya fina* (*C. Calisaya, a vera*, Wedd.), the *Calisaya morada* (*C. Boliviana*, Wedd.), and the tall *Calisaya verde*. They added that the latter was a very large tree, without any red colour in the veins of the leaves, and generally growing far down the valleys, almost in the open plain. A tree of this variety yields six or seven quintals of bark, while the *Calisaya fina* only yields three or four quintals; and Gironda declared that he had seen one, in the province of Munecas in Bolivia, which had yielded ten quintals of *tabla* or trunk-bark alone.

My remarks respecting the position of *C. Calisaya* trees, on the sides of the ravine, only apply to the forest below Lenco-huayccu; above that position they are not found so high up the sides of the mountains, probably owing to their greater proximity to the snowy region of the cordillera. The nearest snow may be about forty miles from Lenco-huayccu, as the crow flies. I also found that the *Calisaya fina* was most abundant about the Yana-mayu, while the variety called *morada* was plentiful in the upper part of the ravine. But it was very difficult for an unpractised eye to detect the slightest difference between these two varieties, until their leaves were placed side by side, when that of the *morada* appeared to be just a shade darker green. Dr. Weddell at first named the *Calisaya morada*, as a distinct species, *C. Boliviana*, but in his later classification he placed it as a variety of the *Calisaya vera*, its bark being very generally collected and sold as that of the latter. No plants which I saw in the forests could be compared, for vigour and regularity of growth, with the tree which I have already described as having been planted on the edge of a clearing; and I think this tends to prove that plenty of light and air is essential to the vigorous growth of the *C. Calisaya*, so long as there is a sufficient supply of moisture, and protection from the direct rays of a scorching sun for the first year or two. The *C. Calisaya* is undoubtedly the most delicate and sensitive of all the species of chinchona.

Above the region occupied by *C. Calisayas*, in the

forests, is the third or upper zone, from 600 to 800 feet above the river. Here, amidst very dense humid vegetation, covered with ferns and mosses, are first met the trees of *C. pubescens* and *Pimentelia glomerata*, and a little higher up are numerous trees of the two valuable species of *C. ovata*, namely, *α vulgaris* and *β rufinervis*, with very large ovate leaves, the latter being distinguishable by the deep red of the leaf-veins. The *Cascarilla bullata* grows with them, and extends still higher up the sides of the mountains. The bark of the *β rufinervis* variety is habitually used to adulterate the Calisaya, which it very closely resembles, and is called *zamba morada* by the cascarilleros, while the *α vulgaris* variety is known as *morada ordinaria*. Martinez said that the *zamba morada* was very tenacious of life, and that, having once thrown away a branch amongst some moss, he found it, a fortnight afterwards, still throwing out shoots. Both varieties of *C. ovata* yield valuable barks.

Above the zone of the *C. ovatæ*, and nearer the snowy cordillera (for lower down the valley the forests cover the crests of the mountains), commence the open grassy *pajonales*, which I have already described. Here the formation is exactly the same as that in the valley of Tambopata; and the vegetation of the thickets which fill the gullies, and are interspersed over the grassy glades, consists of *huaturus*, *Gaultheriæ*, *Vaccinieæ*, *Lasiandræ*, and other *Melastomaceæ*, *Chinchonæ*, palms, and tree-ferns. The chinchonæ consist of *C. Caravayensis*, and of the shrubby variety of *C. Calisaya*, which is called *ychu cascarilla* by the natives. The

shrub *Calisaya* (*β Josephiana*) is generally from six and a half to ten feet high, but I met with an individual plant which I believe to belong to this variety, which had attained a height of eighteen and a half feet; and this inclined me to think, at the time, that this shrubby form could not even be considered as a variety of the normal *C. Calisaya*, and that its more lowly habit was merely due to the higher elevation and more rigorous climate in which it grew. Dr. Weddell remarks that its appearance varies very much according to the situation in which it grows, and that the colour and texture of the different parts change according to the amount of exposure.

I found the shrub *Calisaya* in flower in the end of April.

We crossed two *pajonal* regions, one above the valley of Sandia, and the other between the valleys of Sandia and Tambopata. The height of the former above the level of the sea was 5422 feet, and of the latter 5600 feet. The time of my visit was the end of April and beginning of May, and I traversed both regions twice, so that an abstract of my meteorological observations will give a tolerably correct idea of the climate at that time of the year; although they only extend over the 25th, 26th, 27th, and 28th of April, and a few days in the middle of May.

Mean temperature. . . .	59° Fahr.
Mean minimum at night . .	52
Highest temperature observed. .	67
Lowest „ „ . .	49
Entire range	18
Mean of the dew-point . . .	53·6 (dry bulb as above)

In the early morning there were generally masses of white clouds lying in the ravines, and in the afternoon a thick mist drifted across the *pajonal*, with drizzling rain.

The shrub Calisayas, which were growing plentifully by the roadside, above the valley of Sandia, were entirely exposed, without any shade whatever, and the hill on which they grew had a western aspect. There is a difference in elevation of about 1000 feet between the locality where we saw the shrub Calisayas, and the region of the normal tree Calisaya in the Tambopata forests; and the shrubby form is also many leagues nearer the snows of the cordillera. These circumstances are alone sufficient to account for the difference in the habit of these two forms of *C. Calisaya;* and there seems to be no doubt that the barks of the shrubby varieties of chinchonæ are specially good when their stunted growth is owing to the altitude of the locality.

Our collection of chinchona plants in the Tambopata forests, and on the *pajonales*, was completed on May 14th, as follows:—

	No. of Plants.
C. Calisaya (*calisaya fina*)	237
C. Boliviana (*calisaya morada*)	185
C. ovata, var. *α vulgaris* (*zamba ordinaria*)	9
C. ovata, var. *β rufinervis* (*zamba morada*)	16
C. micrantha (*verde paltaya*)	7
C. Calisaya, var. *β Josephiana* (*ychu cascarilla*)	75
Total	529

CHAPTER XVIII.

JOURNEY FROM THE FORESTS OF TAMBOPATA TO THE PORT OF ISLAY.

ESTABLISHMENT OF THE PLANTS IN WARDIAN CASES.

On May 11th Mr. Weir completed the packing of the plants, and we were preparing for the journey up into the *pajonales* on the following day, having previously fixed on the *Calisaya* trees from which we intended to obtain a supply of seeds in August, when Gironda received an ominous letter from Don José Mariano Bobadilla, the Alcalde Municipal of Quiaca, ordering him to prevent me from taking away a single plant; to arrest both myself and the person who had acted as my guide; and to send us to Quiaca.* I found that an

* "*Alcalde Municipal del Distrito de Quiaca, al Señor Juez de Paz Don Juan de la Cruz Gironda.*

"6 *de Mayo de* 1860.

"Teniendo positivas noticias de que sea internado a los puntos de Tambopata un estranjero Ingles, con objeto de estraer plantas de cascarilla, me es de absoluta necesidad pasarle a vm esta nota, para que sin permitir que en grave perjuicio de los hijos del pais, lo tome ni una planta, por lo que como autoridad debe vm de aberiguar bien para capturar a el y al persona quien se propone a facilitarle dichas plantas, y conducirlos a este.

"Dios guarde a vm.,

"José Mariano Bobadilla."

outcry against my proceedings had been raised by Don Manuel Martel, the red-faced man whom I had met on the road to Sandia, and that the people of Sandia and Quiaca had been excited by assertions that the exportation of cascarilla-seeds would prove the ruin of themselves and their descendants. Gironda, though friendly and hospitable, feared that the finger of scorn would be pointed at him, as the man who had allowed the stranger to injure his countrymen. He wanted to throw away all the plants, except a few which we might take without observation, and, if we had not kept constant guard over them, he would have carried his views into effect without consulting us. I saw that in an immediate retreat was the only hope of saving the plants; and I explained to Gironda that his views were incorrect, that I should be the last person to injure the Peruvians or their interests, and that, if necessary, we were prepared to defend our property by force.

At the same time I addressed a letter to Don José Bobadilla, stating that his interference was illegal; and that, as I understood the provisions of the Peruvian Constitution of 1856, the functions of the *Juntas Municipales* were purely consultative and legislative, conferring no executive powers. I concluded with an expression of my sense of his patriotic zeal, and of regret that it should be accompanied by such misguided and lamentable ignorance of the true interests of his country. Nevertheless, I felt the imperative necessity of immediate flight, especially as I obtained

information from an Indian of Quiaca that Martel's son and his party, who had brought the letter, were only the vanguard of a body of mestizos, who were coming down the valley to seize me, and destroy my collection of chinchona plants.

Early in the morning of May 12th we took leave of our kind and hospitable old friend Gironda, without whose assistance we should have been exposed to much suffering from want of food; and of the honest forester Martinez. I expressed my sincere regret to Gironda that any misunderstanding should have arisen at the close of our acquaintance, and promised Martinez to obtain guarantees that he should suffer no molestation on account of the services he had rendered to me. The most melancholy part of travelling is the parting with friends, never to meet again.

After a laborious ascent through the forest we found Martel's son and his party stationed on the verge of the *pajonal*. They were evidently waiting for us, but did not attempt to impede our passage, and a display of my revolver, although it may have been very efficacious, was perfectly harmless, as the powder was quite damp. The young Martel asked the Indians in Quichua how they dared to carry the plants, and called after them that they would be seized at Sandia; but he was civil to me, and we continued our journey peaceably, though full of apprehensions at the turn affairs might take on our arrival at Sandia.

We had to cross the same country as we had traversed in our journey to the Tambopata valley; and, in skirting

along the verge of a ridge, near the Marun-kunka, the cargo-mule fell headlong down a precipice of twenty feet into a dense mass of trees and underwood. We could see the poor beast's legs kicking in the air, but it was long before we could reach her, and more than two hours before a circuitous path could be cut and cleared away to extricate her. We encamped on the pajonal, and next day, after a very laborious walk of twelve hours, we reached the Ypara tambo, in the valley of Sandia, Mr. Weir having collected twenty plants of *Calisaya Josephiana* on the way. On May 14th we continued our journey towards Sandia, and collected fifty-five more plants of *Calisaya Josephiana* on the pajonal of Paccay-samana, chiefly seedlings.

The water of the numerous cascades is very refreshing, and as beautiful in its limpid transparency as when it dashes down the rocks in dazzling streams of purest white. We were now too in the land of luscious oranges and chirimoyas. The commonest bird in the valley of Sandia is the *cuchu*, a kind of large crow, with a shrill weak caw. It has a long yellow bill, greenish-brown body and wings, rump-feathers red, and a long bright yellow tail, with a black line down the centre. The *cuchus* walk about the fields eating the young maize, and perch upon the adjoining trees. Humming-birds are numerous, and very beautiful; I saw also a little cream-coloured hawk, and lordly eagles were soaring over the ravine, having their eyries in the inaccessible parts of the lofty cliffs. Approaching Sandia in the early morning of May 15th, I came

upon many groups of Indians, with their wives and daughters, who had slept in the road, on their way to and from their coca harvests. They were boiling their breakfasts of potatoes over little fires of dry sticks, which crackled pleasantly. Grand precipices towered up on either side of the valley, and in the bottom, where the bright river was murmuring on its way, there was a hut in a field of maize, surrounded by the drooping crimson flowers of the "love-lies-bleeding," with a girl in a bright blue woollen dress sitting at the door.

On arriving at Sandia I went through the ceremony of paying off my Indians, and taking leave; and Vilca, Ccuri, and Quispi returned to their homes. I formed a very high opinion of the Indian character from my experience with these my fellow-labourers. Suspicious they certainly were at times, and with good reason after the treatment they have usually met with from white men, but willing, hard-working, intelligent, good-humoured, always ready to help each other, quick in forming the encampments, conversing quietly and without noise round the camp-fires, and always kind to animals; altogether very efficient and companionable people.

I found things at Sandia in a very alarming state; most of the people had been excited by letters from Quiaca to prevent me from continuing my journey with the chinchona plants, and a sort of league had been made with other *Juntas Municipales* to protect their interests, and prevent foreigners from injuring them.

The tactics which were adopted would have succeeded in their object, but for a great piece of good luck. I was prevented from hiring mules, except to go to Crucero, where I knew Martel was stationed, with the intention of raising obstacles to my further progress until the plants had been killed by the frost. I meditated setting out on foot, with all the four bundles of plants on my own mule, when Don Manuel Mena told me confidentially that, if I would give him my gun, he would get an Indian to supply beasts, and accompany me to Vilque, on the road to Arequipa. I willingly agreed to this bargain, and sent Mr. Weir and the lad Pablo to Crucero, so as to throw Martel off the scent, while I hurried the plants down to the coast by the most unfrequented line of country.

An alarm had, however, been spread through all the villages bordering on the chinchona forests, both in Caravaya and Bolivia, and I ascertained that effectual measures had been taken to prevent my return for seeds in August. Martel had also written to the towns and villages between Crucero and Arequipa, to put obstacles in the way of my retreat, so that I found it necessary to avoid entering any town or village, and to shape a direct compass-course over the cordilleras from Sandia to Vilque. I also reluctantly abandoned my intention of returning to collect seeds in August. But I made arrangements to obtain a supply from selected trees, through a reliable friend, in the ensuing year.

In the morning of May 17th I left Sandia on my

own trusty mule, driving two others with the plants before me, and accompanied by their owner on foot, an Indian named Angelino Paco, a middle-aged respectable-looking man, who had been one of the Alcaldes of Sandia in 1859. Mr. Weir started for Arequipa on the same day, by way of Crucero. Passing through Cuyo-cuyo without stopping, I continued to ascend a mountain-gorge, by the side of the stream, but Paco had never been out of the valley of Sandia before, and was useless as a guide. All along the banks of the stream there were square pools dammed up and filled with heaps of potatoes and ocas, placed there to freeze into *chuñus*, the principal food of the Indians when in the forests, or on the coffee or coca estates. Higher up the gorge all signs of habitation cease, though there are still abandoned tiers of ancient terraces, and the mountain scenery is quite magnificent. Night coming on without a moon, I halted under a splendid range of frowning black cliffs, and succeeded in pitching the tent in the dark; but there was no fuel, and on opening the leathern bag I found that my little stock of food and lucifer-matches had been stolen in Sandia. I was thus entirely dependent for existence on Paco's parched maize, which proved uncommonly hard fare. The cold was intense during the night, and penetrated through the tent and clothes to the very marrow.

At daybreak Paco and I loaded the mules, and continued to ascend the gorge by the side of the river of Sandia, which becomes a noisy little rill, and finally falls, as a thin silvery cascade, over a black cliff.

Reaching the summit of the snowy cordillera of Caravaya, we commenced the journey over lofty grass-covered plains, where the ground was covered with stiff white frost. There were flocks of vicuñas on the plain, and *huallatas*, large white geese with brownish green wings and red legs, on the banks of the streams; but as we advanced even these signs of life ceased, and, when night closed in, I looked round on the desolate scene, and thought that to make a direct cut across the cordilleras to Vilque by compass-course was a very disagreeable way of travelling, though, in this case, a necessary one. I had been eleven hours in the saddle, when Paco found an abandoned shepherd's hut, built of loose stones, three feet high, and thatched with *ychu* grass. The minimum thermometer, during the night, was as low as 20° Fahr. by my side.

At daylight on May 19th Paco complained of having to rise before the sun, although he must have been half-frozen. The mules had escaped, and we were fully three hours in catching them. The ground was covered with a crisp frost, and during the forenoon we were travelling over the same lofty wilderness, consisting of grassy undulating hills, with ridges of cliffs, and huge boulders here and there. The view was bounded on the north and east by the splendid snowy peaks of the Caravayan range, and to the north-west by those of Vilcañota. The only living things, in these wild solitudes, are the graceful *vicuñas*, which peered at us with their long necks from behind the grassy slopes, the *guanacos*, the *biscaches* burrowing amongst the rocks,

and the *huallatas* or large geese on the margins of streams or pools of water.

At about noon we began to descend a rocky dangerous cuesta, where there was much trouble with the mules, which were constantly attempting to lie down and roll with the plants. The steep descent led into the plain of Putina, which was covered with flocks of sheep, with small farms, shaded by clumps of *queñuar* trees, nestling under the sandstone cliffs which bound the plain. Crossing another range, we reached a swampy plain, with sheep and cattle scattered over it, and stopped at an abandoned shepherd's hut, the exact counterpart of last night's lodging. I had been ten hours in the saddle, and was faint from hunger, but had to go supperless to bed. Paco was nearly breaking down from a bad wound in his foot, but I bandaged it with lint, and he was able to proceed. He had an *alco* or Peruvian dog with him, which was devotedly attached to its master. These dogs are something like Newfoundlands, only much smaller, generally black or white, and they seldom bark.

On the morrow the way, for the first two hours, led over grassy hills covered with flocks of sheep, with shepherd-lads playing on *pincullus*, or flutes, the sound of which came floating pleasantly on the air, from every direction far and near. We passed several blue mountain-lakes, with islands of rushes, and many ducks. From 10 A.M. until sunset the whole day was occupied in crossing a vast plain covered with sheep and cattle, and just after sunset we reached a small

estancia or sheep-farm. It was occupied by a large family of good-tempered Indians, whose eyes glistened when I offered them a *cesto* of coca which I had with me, in exchange for unlimited supplies of milk and cheese. It was pleasant to see their happiness at the acquisition of this treasure, which was shared by the children and dogs. The place was full of guinea-pigs, which are considered great delicacies. The extreme hunger from which I had suffered since leaving Sandia was here relieved by plenty of milk, cheese, and parched maize. Every night I had wrapped the Russian mats, which enveloped the plants, in warm ponchos, and the tent. The crooked wriggling queñuar branches, which formed the roof of the hut, looked like snakes in the dim light after sunset.

At sunrise on May 21st there was a white frost, and the deep blue sky was without a single cloud. Suddenly an immense flock of flamingoes, called *parihuanas* * in Quichua, rose in a long column from the margin of the river of Azangaro, which flows through the plain. These birds, with their crimson wings and rose-coloured necks and bodies, whirring up in a long spiral column, formed one of the most beautiful sights I ever saw.

Crossing a range of rocky hills, we entered a plain, which extended to the banks of a large lake, with the little town of Arapa built along the shore. Dark

* Hence the name of the Peruvian province of *Parinacochas*. *Parihuana-cocha*, the Flamingo lake.—G. de la Vega, *Comm. Real.* i. lib. iii. cap. ix. p. 83.

mountains rise up immediately in the rear. I believe that I am the first English traveller who has ever visited this lake, and M. de Castelnau, who obtained some information respecting it at Puno, says that it is not to be found in any map.* Along the shores there were long rows of flamingoes, standing like a gigantic regiment, with a few skirmishers thrown out fishing. There were also *huallatas*, ibises, ducks, and a stout-built stunted sort of crane. Journeying on, we began to cross a vast plain which extends for many leagues round the north-west corner of lake Titicaca, and is dotted with walled *estancias* and flocks of sheep. At length we reached the ford over the river of Azangaro, in sight of the little village of Achaya, to the left. The water came above the mules' bellies, and, crossing half a mile of swampy ground, we came to another ford over the river of Pucara. The two rivers, uniting just below Achaya, form the Ramiz, the largest feeder of lake Titicaca. We continued our way for many hours over the plain, until we reached an Indian's hut long after dark, having been twelve hours in the saddle, at the

* "We give here the notices which we have collected respecting the existence and position of a lake which is not to be found in any map, and which bears the name of Arapa. It is said to be six leagues to the north of lake Titicaca, and is thirty leagues in circumference. It extends from the foot of a very abrupt chain of mountains, and its figure is that of a half-moon. It contsins some islands. Its waters, having traversed two other smaller lakes to the west, fall into the Ramiz, which is thus rendered navigable at all seasons. The principal villages around the lake of Arapa are Chacamana, Chupan, Arapa, and Vetansas. Round the latter place it is said that there are many veins of silver and mines of precious stones."—*Castelnau*, tom. iii. chap. xxxix. p. 420.

slow tedious pace of a tired mule. The cargo-mules had played every kind of vicious trick throughout the day, running off in different directions at every opportunity, and constantly trying to roll.

Starting at daybreak on the 22nd, we forded the river of Lampa, crossed the road between Lampa and Puno, passed over a rocky cordillera and a wide plain, and reached the little town of Vilque by four in the afternoon. The place presented a very different appearance from the time when we passed through it in March, on our way to Puno. It was now the time of the great yearly fair, when buyers and sellers from every part of South America flock to the little *sierra* town. This great gathering was first established in the time of the Spaniards, and it is not improbable that the Jesuits, who once possessed the great sheep-farm of Yanarico near Vilque, and who always looked well after the improvement of their property, may have been the great promoters of the fair.

Outside the town there were thousands of mules from Tucuman waiting for Peruvian arrieros to buy them. In the plaza were booths full of every description of Manchester and Birmingham goods; in more retired places were gold-dust and coffee from Caravaya, silver from the mines, bark and chocolate from Bolivia, Germans with glass-ware and woollen knitted work, French modistes, Italians, Quichua and Aymara Indians in their various picturesque costumes—in fact, all nations and tongues. In the plaza, too, there were excellent cafés and dining-rooms, all under canvas; but

house-rent was exorbitant, and a lodging was not to be had for love or money. There was much complaint of the injury done to trade by the threatened war with Bolivia, and the edict of President Linares, prohibiting all intercourse with Peru.

I placed the bundles of plants, carefully wrapped round with ponchos, in a barley-field occupied by arrieros, covered over with their warm *aparejos;* but the thermometer was down to 23° Fahr. in the night.

In the afternoon of the 23rd I left Vilque for the sheep-farm of Taya-taya, in company with Dr. Don Camillo Chaves, the superintendent. The road was crowded with people coming from Arequipa to the fair at Vilque: native shopkeepers, merchants coming to arrange for their supplies of wool, and a noisy company of arrieros on their way to buy mules, and armed to the teeth with horse-pistols, old guns, and huge daggers, to defend their money-bags. Many of them were good-looking fellows, the older ones bearing signs of hard drinking.

The sheep-farm of Taya-taya,* four leagues from Vilque, is a range of mud-plastered buildings with thatched roofs, built round a large *patio,* on a bleak plain surrounded by mountains. In the morning a flock of forty llamas were being laden with packs of wool in the *patio,* at which they were making bitter lamentations. We started early on May 24th, and encountered a cold gale of wind, blowing in icy squalls over the cordillera. I reached the posthouse of Cuevillas

* *Taya* is an Aymara word, meaning "cold."

in the night, a distance of forty-five miles; got as far as the post house of Pati the next day; encountered a tremendous gale of wind on the skirts of the volcano of Arequipa, but descended to the valley of Cangallo on the 26th; and rode into the city of Arequipa, with my plants, on the morning of the 27th of May. Mr. Weir and the lad Pablo arrived from Crucero on the 29th, having, as I expected, found Martel in that town, whose designs were thus baffled. From Sandia to Arequipa is a distance of nearly 300 miles. No opposition was made to my departure from Arequipa, although the local newspaper had something to say afterwards,* and on June 1st the plants were safely deposited in the Wardian cases at the port of Islay.

But the difficulties of getting the plants out of the country were not entirely ended by my escape from Martel and the *Juntas Municipales* of the interior. The Superintendent of the Custom-house of Islay refused to allow them to be shipped without an express order from the Minister of Finance and Commerce at Lima. He had probably received intelligence respecting the contents of the cases from Vilque, where all news

* *La Balsa de Arequipa*, Junio 15.

"Las cuestiones municipales han hecho gran daño al puerto de Islay, pues todo va mal con el desacuerdo que reina entre el cuerpo y las demas autoridades que lo combaten escandalosamente.

"Quiero que se sepa en esa ciudad que los estranjeros han dado en esportar por esta plantas de cascarilla, que es sabido esta prohibido hacerlo: acaba de embarcar un Ingles una multitud de ellas para la India, por comision official de su Gobierno. Yo no sé como es que esto se tolera, defraudando asi uno de los mejores y mas esclusivos ramos de nuestra riqueza."

centres at the time of the fair. This obliged me to go to Lima to obtain the necessary order from Colonel Salcedo, the Minister of Finance, which I succeeded in doing, and returned with it to Islay on June 23rd.

Meanwhile, since the plants had been established in the Wardian cases, they had begun to bud and throw out young leaves, which seemed to prove that they had quite recovered from their journey across the arctic climate of the Andes. In the evening of the 23rd the cases were hoisted into a launch, ready to go on board the steamer on the following morning; and during the night attempts were made to bribe the man in charge to bore holes and kill the plants by pouring in boiling water, but without success. On the following day they were safely lodged on board the steamer bound for Panama.

It was impossible not to feel regret that H.M. steamer *Vixen*, then lying idle at Callao, had not been ordered to take the plants direct across the Pacific to India, in which case they would have arrived in perfect order. But this was not to be, and we had to look forward to long voyages, several transhipments, and the intense heat of the Red Sea, before this most valuable collection of plants could reach their destination in Southern India.

Yet it could not but be satisfactory to look back upon the extraordinary difficulties we had overcome, the hardships and dangers of the forests, the scarcity of the plants, the bewildering puzzle to find them amidst the dense underwood, the endeavour to stop my journey,

first at Tambopata and then in Sandia, the rapid flight across unknown parts of the cordillera, and the attempts first to stop and then to destroy the plants at Islay: it was a source of gratification to look back upon all this, and then to see the great majority of the plants budding and looking healthy in the Wardian cases. So far as our work in South America was concerned, it had been performed with complete success. The seeds, for the collection of which I made arrangements at Sandia, reached me in due course.

CHAPTER XIX.

MR. LEDGER'S SERVICES IN PROCURING CALISAYA SEEDS FROM BOLIVIA.

MR. CHARLES LEDGER, who obtained a valuable supply of Calisaya seeds as his contribution towards the great work of introducing chinchona cultivation into India, had been a resident in Peru and Bolivia since 1836. He was engaged in the bark and alpaca wool trades, and in 1845 was settled at Puno. In that year he joined an expedition which had been organised, owing to the bark monopoly in Bolivia, to search for valuable species of chinchona trees in the forests of Caravaya. Mr Ledger started with a party of fifty-six, but they returned after fifty-seven days, having failed to discover the objects of their search. An idea existed that there were no Calisaya trees in Peru, and a preconceived notion was doubtless the cause of their failure. This erroneous belief was finally disposed of by Dr. Weddell, when he visited the forests of Caravaya, and brought back specimens of the same Calisayas that are found in the Bolivian montaña.

In 1850 Mr. Ledger became a partner with Mr. Backhouse,* in an expedition to search for Calisaya

* George Backhouse was a son of Mr. John Backhouse, a clerk in the Foreign Office under Mr. Canning, and afterwards Under Secretary of

trees in the Santa Ana and Marcapata valleys in Peru. He purchased, and transmitted from Puno, stores to the value of £1400, but Mr. Backhouse was murdered by the wild Chuncho Indians, the expedition was broken up, and Mr. Ledger lost all he had invested in this enterprise. His next undertaking was an attempt to reach the Amazon through the Bolivian province of Caupolican. This was in 1851. He was accompanied by an intelligent and most faithful Indian servant named Manuel Incra Mamani, who had already been in his employment since 1843, sorting and packing bark and alpaca wool. It was on the banks of the Mamoré that Mr. Ledger saw the Calisaya trees, but he has not visited the forests where chinchonas grow since the year 1851.

In 1858 Mr. Ledger succeeded in the difficult and hazardous undertaking of bringing a flock of alpacas over the wild and bleak cordilleras of Bolivia to the sea-coast, and embarking them for Australia; and he personally conveyed them to their new homes. On his return to South America he heard of the enterprise which I had initiated and put in train, for introducing chinchona cultivation into India. It appears that he

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State for Foreign Affairs from 1827 to 1834. He was also on the Council of the Royal Geographical Society from 1836 to 1841. Young George Backhouse went out to Peru as an adventurer, and in 1851 joined this expedition into the bark forests, which was led by Colonel Bolognesi. It appears that a dispute between the Indians of the expedition and the wild Chunchos led to an affray in which Backhouse was killed. The locality of this catastrophe was the montaña of Marcapata, north of Caravaya.

made some attempt to open communications with me, which unfortunately was not successful. If I had received any proposal from him I should, without hesitation, have taken upon myself the responsibility of engaging Mr. Ledger's services, and he would then certainly have received some, though probably very inadequate, remuneration. As it is, he has actually been refused any reward, and he is a great loser from from having so zealously co-operated in the good work.

In his endeavour to secure a supply of the best Calisaya seeds, Mr. Ledger sent for his old servant Manuel in 1861, and gave him the necessary instructions for collecting seeds from the best kinds of cascarilla trees. The Bolivian bark collectors recognise three kinds, called *roja, morada,* and *naranjada.* The leaves of the *roja* variety of Calisaya are bright scarlet underneath, and dark green above. This kind is considered to produce the richest bark.

Manuel Mamani, with his sons, proceeded to the chinchona forests as bark collectors, but the best trees did not produce ripe fruit for four years. When in full flower and most promising, a frost in April always destroyed the ripening prospect. Old Manuel waited patiently, year after year, cutting bark with his sons and looking out for an opportunity of fulfilling Mr. Ledger's commission. At last the time came. He gathered seeds from about fifty trees, chiefly of the *roja* kind, and safely delivered them to Mr. Ledger, in June 1865. He was paid well, and instructed to return for more seeds of the *roja, morada,* and *naranjada* varieties

of Calisaya. Poor Manuel's fate was very melancholy. The Bolivians are extremely jealous of their bark monopoly. The Corregidor of Coroico, one of the forest provinces to the east of the Andes, seized the seed collector and threw him into prison, where he was beaten to make him confess who the seeds found on him were for. After being confined in prison for about three weeks, beaten and half starved, he was at last set at liberty, robbed of his donkeys and blankets, and all he possessed. This most faithful old servant, the true-hearted Manuel Incra Mamani, died from the ill-treatment he had received very soon afterwards.

Manuel's son brought the news to Mr. Ledger, having come to account honestly for the money his father had received. It is a sad story; but at the same time it is very pleasant to have to record these noble traits of character in the Indians, the descendants of men who formed and organised the glorious empire of the Yncas. Owing to the dangers to which the poor Indians were exposed in collecting seeds, Mr. Ledger resolved not to employ them again on such hazardous duty. Old Manuel had served him faithfully for thirty years.

The seeds collected in 1865, and delivered to Mr. Ledger in June of that year, were very carefully and judiciously dried and packed, and arrived at their destination in excellent condition. They were sent to London, to the care of Mr. Ledger's brother, who sold half to the Dutch Government for the Java plantations, and half to Mr. Money, a chinchona planter on the

Nilgiri hills. As many as 20,000 seeds germinated in Java, and a still greater number in India, producing numerous varieties. The plants, of which 7000 survived in Java, had increased in number to 40,000 in in 1874, and in 1875, 10,977 had been planted out.

These plants yield an extraordinarily large quantity of quinine, as much as 9·97 per cent. In this respect they are unequalled, so that the service thus performed by Mr. Ledger is one of very great importance, which deserves special recognition. In a future chapter I shall put on record the amount of recognition vouchsafed to each of my fellow-labourers in this beneficent enterprise.

Mr. Howard has appropriately named the richest of quinine yielding trees the *C. Calisaya*, var. *Ledgeriana.*

CHAPTER XX.

DR. SPRUCE'S EXPEDITION TO PROCURE PLANTS AND SEEDS OF THE "RED BARK," OR *C. SUCCIRUBRA.*

THE species of chinchona, known as the "red bark" tree (*C. succirubra*), yields a larger percentage of febrifuge alkaloid than any other, and I therefore consider it to be the most important. Its native forests are on the western slopes of the famous mountain of Chimborazo, in the Republic of Ecuador, and for a great many years it has not been found beyond 2° 36′ S. lat.; but Dr. Spruce thinks it probable that in former times the tree grew all along the roots of the Andes of Cuenca and Loxa to the limits of the Peruvian desert in 5° S. To the north it scarcely passes the latitude of 1° S.; and these precious trees are thus confined within a very narrow latitudinal zone.* Within the ascertained limits of the true "red bark" tree, it exists in all the valleys of the Andes which debouch on the plain of Guayaquil; but great havoc has been made amongst the trees of late years by

* There is no ascertained law by which many of the species of the chinchona genus are thus limited to narrow zones as regards latitude. Dr. Spruce mentions that on the lower regions of the Andes of Pasto and Popayan, in New Granada, there are the conditions of climate and altitude requisite for the growth of *C. succirubra*, but it has not been found there.

the bark collectors. In the valleys of Alausi, Pallatanga, and Chillanes all the large trees have already been cut down. At the bases of the ridges of Angas and San Antonio, the localities originally mentioned by Pavon, and where "red bark" trees once grew in abundance, the same destructive system had been adopted; and now the "red bark" grounds are confined to the ravine of the river Chasuan, and its tributaries, which rise on the northern slopes of Chimborazo, and fall into the river of Guayaquil.

On the 22nd of July 1859 Dr. Spruce set out from the pleasant town of Ambato, in the Quitenian Andes, where he was then residing, and, passing through Alausi, arrived at the banks of the river Chanchan, and established himself at a place called Lucmas, which is conveniently near the "red bark" chinchona forests. Lucmas is a sugar-cane farm, between 5000 and 6000 feet above the sea; there are forest-trees in the valleys and on the hills, while the steep slopes are often covered with scrub and grass. From Lucmas Dr. Spruce went to the forests on the banks of the river Pumachaca, which rises in the mountain of Asuay, and falls into the Chanchan, at an elevation of 4000 feet. One circumstance, among many, will give an idea of the difficulties which he had to encounter. On reaching the Pumachaca he found that the ford had been destroyed by the falling of a cliff, and that in its place there was a deep whirlpool; so, with the driftwood along the banks, a bridge had to be made where the river was narrowed between two rocks, by which his

party crossed with the baggage. Then, after a long search, he found a place where the horses could swim across, and, by rolling down masses of earth and stones, a way was made for them to ascend on the other side. Once across, a hut was made among vegetable-ivory palms, thatched with the palm-fronds, and Dr. Spruce commenced the examination of the forest.

After a long search, during which he passed several felled trunks of chinchona trees, he at length came upon a root-shoot about twenty feet high. It is very rare to find these root-shoots, because the bark is stripped from the roots as well as from the trunk. Dr. Spruce, from his observations in the Pumachaca forest, came to the conclusion that the "red bark" trees grow best on stony declivities, where there is, however, a good depth of humus, at an elevation of from 3000 to 5000 feet above the sea. The temperature was very like that of a summer day in London, but with cold mists towards evening, and from January to May unceasing rain. He found the chinchona trees, in this part of the country, almost entirely extirpated, and, after a short stay at Lucmas, he proceeded to examine the region of the "hill barks," or *cascarillas serranas*, which is at an elevation of 8500 to 9000 feet, on both sides of the river Chanchan. In the forest of Llalla, at the foot of the mountain of Asuay, he found two kinds, called by the natives *cuchi-cara* (pig-skin) and *pata de gallinazo*;* and on a stony hill side there were twenty large trees of the former, from 40 to 50 feet high.

* This is not the same as the *pata de gallinazo* of Huanuco, which has been named by Mr. Howard *C. Peruviana.*

By this excursion in the summer of 1859 Dr. Spruce ascertained the districts to which he should not go, a very important point; and he finally determined to carry on his collecting operations, in the season of 1860, at a place called Limon, at the junction of a stream of that name with the river Chasuan, which falls into the river of Ventanas at a place called Aguacatal. The forests are all private property, and, after much negotiation with the owners, Señor Cordovez of Ambato, and Dr. Neyra of Huaranda, an agreement was made by which, on payment of 400 dollars, Dr. Spruce was allowed to take as many seeds and plants as he liked, on condition that he did not touch the bark.

Dr. Spruce had a severe rheumatic and nervous attack, almost amounting to paralysis, in the early part of 1860, which induced him to resign the duty of collecting the "red bark" to Dr. Taylor of Riobamba, and it was only at the last moment that he was strong enough to undertake the journey in company with his friend. During the whole time that Dr. Spruce was at work he was suffering severely from illness; the benefit derived from the milder climate of the forests was neutralised by the fogs and damp; and, to use his own words, "although upheld by a determination to execute to the best of my ability the task I had undertaken, I was but too often in that state of prostration when to lie down quietly and die would have seemed a relief." Leaving the town of Ambato on the 11th of June, 1860, Dr. Spruce and Dr. Taylor reached Huaranda on the 13th, and continued their journey

towards the forests on the 17th. At a very little below 4000 feet above the sea they reached the small farms at Limon. Their abode stood on a narrow ridge sloping gradually to the river Chasuan. It was merely a long low shed, two-thirds of which was occupied by the rude machinery of a sugar-cane mill; the remaining third had an upper story with a flooring of bamboo plants, half of it open at the sides, and the other half with a bamboo wall about six feet high, not coming up to the roof in any part of it. This was their dormitory, and it was reached by a ladder, merely a trunk of a tree with rude notches for steps. On the ground-floor was the kitchen, with a wall of rough planks of raft wood, not touching each other; so that the whole fabric was abundantly ventilated, and only too often filled with fog, causing coughs, aching limbs, and mouldy clothes.

This was their head-quarters during the time that they were collecting seeds and plants; and the severe hardships, miserable lodging, and acute sufferings from illness must increase our admiration for Dr. Spruce's zeal and resolution in performing this great public service.

Mr. Cross, the gardener whom I had engaged to assist Dr. Spruce, conveyed the fifteen Wardian cases, which I had previously sent to Guayaquil, up the river as far as Ventanas, and reached Limon on the 27th of July.

In the meanwhile Dr. Spruce had carefully examined the chinchona forests, and visited all the bark

trees known to exist within reach of Limon. He found a good crop of capsules on many of them, which had already nearly reached their full size on the finest trees; on others, however, there were only very young capsules, and even a good many flowers, and not one of the late-flowering panicles produced ripe capsules. On the tree which bore most capsules they began to turn mouldy, the mould being not fungi, but rudimentary lichens, which, whilst it proved that the capsules were still alive and growing, proved also that they were exposed to an atmosphere almost constantly saturated with moisture.

The *manchon* or clump of "red bark" trees at Limon lies nearly west from the peak of Chimborazo, and the river Chasuan rises on the northern shoulder of that mountain. The view from Limon takes in a vast extent of country, and the whole is unbroken forest, save towards the source of the Chasuan, where a lofty ridge rises above the region of arborescent vegetation, and is crowned by a small breadth of grassy *paramo*. The waters of the Chasuan run over a black or dull blue, shining, and very compact trachyte, over which, in the bottom of the valleys at Limon, there is a fine-grained ferruginous sandstone of a deep brown colour, in thick strata. The soil is a deep loamy alluvial deposit. The ridges on which the "red bark" trees grow all deviate a little from an easterly and westerly direction, and the chinchonæ are far more abundant on the northern than on the southern slopes. The northern and eastern sides of the trees, too, had borne most fruit,

and scarcely a capsule ripened on their southern and western sides. This is explained by the trees receiving most sun from the east and north, the mornings being generally clear and sunny in the summer, whilst the afternoons are foggy, and the sun's declination is northerly. Dr. Spruce also observed that the trees standing in open ground were far healthier and more luxuriant than those growing in the forest, where they are hemmed in and partially shaded by other trees; and he concluded, from this circumstance, that, though the "red bark" tree may need shade whilst young and tender, it really requires (like most trees) plenty of air, light and room wherein to develop its proportions.

The lower site of the "red bark" tree at Limon is at an elevation of 2450 feet above the sea, and its highest limit is at an elevation of about 5000 feet. The trees nearest the plain are generally the largest, but those higher up have much thicker bark in proportion to their diameter.

The havoc committed by the bark collectors on these trees within the previous twenty years had been very great. The entire quantity of "red bark" collected in 1859 did not reach to 5000 lbs., and in 1860 no "red bark" at all was got out, so that the trade was nearly extinct. In the valleys of the Chasuan and Limon Dr. Spruce saw about 200 of these trees standing, but only two or three were saplings which had not been disturbed; all the rest grew from old stools, whose circumference averaged from 4 to 5 feet. He was unable to find a single young plant under the trees, although

many of the latter bore signs of having flowered in previous years; and this was explained by the flowering trees invariably growing in open places, where the ground was either weeded, or trodden down by cattle.

Dr. Spruce described the *C. succirubra* or "red bark" tree as very handsome, and he declared that, in looking out over the forest, he could never find any other tree at all comparable to it for beauty. It is 50 feet high, branching from about one-third of its height, with large, broadly ovate, deep green, and shining leaves, mixed with decaying ones of a blood-red colour, which give it a most striking appearance.

The *Cascarilla magnifolia*, a very handsome tree, with a fragrant white flower, grows abundantly with the "red bark," and attains a height of 80 feet.

After the arrival of Mr. Cross at Limon the work of collecting commenced in earnest. A piece of ground was fenced in, and Mr. Cross made a pit and prepared the soil to receive cuttings, of which he put in above a thousand on the 1st of August and following days; and he afterwards went round to all the old stools and put in as many layers from them as possible. "But," as Dr. Spruce most truly observes, "only those who have attempted to do anything in the forest, possessing scarcely any of the necessary appliances, can have any idea of the difficulties, and Mr. Cross's unremitting watchfulness alone enabled him to surmount them."

Towards the end of July, in a few sunny days, the fruit of the "red bark" trees made visible advances towards maturity; and in the middle of August the

capsules began to burst at the base, and appeared ripe. An Indian was then sent up the trees, and, breaking the panicles gently off, let them fall on sheets spread on the ground to receive them, so that the few loose seeds shaken out by the fall were not lost. The capsules were afterwards spread out to dry for some days on the same sheets. In September Dr. Spruce went across to the valley of the San Antonio, to the southward, in order to secure additional seeds from "red bark" trees there, leaving Mr. Cross to watch over the rooting of the cuttings at Limon. Between the 14th and 19th he gathered 500 well-grown capsules at San Antonio, in addition to 2000 already collected at Limon. They were good capsules containing forty seeds each, so that at least 100,000 well-ripened and well-dried seeds were now gathered; and on the 28th of September Dr. Spruce started for Guayaquil.* In November he proceeded up the river again, and purchased one of the rafts at Ventanas, which are used for conveying cacao to Guayaquil. It was composed of twelve trunks of raft-wood, sixty-three to sixty-six feet long and one foot in diameter, kept in their places by shorter pieces tied transversely,

* Mr. Cross sowed eight of the seeds; one began to germinate on the fourth day, and at the end of a fortnight four seeds had pushed their radicles. In three weeks one had the seed-leaves completely developed; and on the twenty-eighth day after sowing, the last of the eight pushed its radicle. Eight chinchona seeds, gathered by Dr Spruce in 1859, were sown at Guayaquil, which had remained nine months in his herbarium. Of these four germinated, which clearly shows that well-ripened and properly-dried seeds do not lose their vitality for a much longer period than their excessive delicacy would lead one to suspect.

and covered with bamboo planking, fenced round with rails to a height of three feet, and roofed over. The rope used for binding the parts of the raft together was the twining stem of a *Bignonia*. The Wardian cases were got ready on the raft at Ventanas, and Mr. Cross arrived with the plants from Limon on the 13th of December, and established them in the cases to the number of 637.

After encountering several dangers and mishaps in navigating the river, the raft with its precious freight reached Guayaquil on the 27th of December; and the plants were safely embarked on board the steamer, in charge of Mr. Cross, on the 2nd of January, 1861.

Thus skilfully and successfully did Dr. Spruce, and his able colleagues, perform this most difficult and important service. Dr. Spruce, during the whole time that he was in the chinchona forests, made most careful meteorological observations. From June 19th to December 8th the results of observations of the thermometer were as follows:—

Mean minimum . .	61½°
Mean maximum . . .	72½
Mean temperature at 6½ P.M. .	67¾
Highest temperature observed .	80½ on July 27th.
Lowest „ „ .	57 on July 11th.
Entire range	23½
Mean daily variation . .	10½

On the western side of the Quitenian Andes, south of the equator, the summer or dry season lasts from June to December, the remaining five months constituting the wet season. In the summer, at Limon, the early

part of the day is often sunny, and fogs come on in the afternoon and night; but in the wet season there are fogs in the morning, and heavy rains during the rest of the day and night.

A perusal of the foregoing pages cannot fail to impress the reader with the valuable nature of the service which was performed, and with the energy and fortitude, combined with great skill and ability, which enabled Dr. Spruce to overcome so many difficulties; and almost equal praise is due to Mr. Cross. Dr. Spruce also supplied me with a detailed report which, I do not hesitate to say, contains a larger amount of valuable information on the chinchona forests than any account which has yet appeared in Europe. In addition to the narrative of his proceedings, and his observations on the "red bark" tree, Dr. Spruce here gives a minute account of the vegetation of the "red bark" forests of Chimborazo, a detailed meteorological journal, and important remarks on the climate and soil.

CHAPTER XXI.

MR. PRITCHETT'S EXPEDITION TO PROCURE PLANTS AND SEEDS OF THE GREY BARK SPECIES IN THE HUANUCO FORESTS.

THE collection of plants and seeds of the species yielding grey barks, in the Huanuco forests, to the north of Lima, was desirable, because, although these species do not yield quinine, yet they contain other febrifuge alkaloids. I entrusted this duty to Mr. Pritchett, who did not arrive on the South American coast until after I had started for the interior. On reaching Lima, he received detailed instructions which were drawn up by Mrs. Markham, who also supplied him with the necessary funds. On the receipt of these instructions, Mr. Pritchett left Lima for Huanuco on the 18th of May, 1860.

He arrived at Huanuco, a town on the verge of the grey bark region, on the 28th of May, and made the necessary preparations for a journey into the neighbouring forests. On the 9th of June he set out for the mountain range of Carpis, to the northward, where there are several species of chinchona. The *C. purpurea* is very abundant; the *C. nitida* is common on the north-east side, and on the upper part of the

mountains; the *C. obovata* is more rare; and the *C. micrantha* and *C. Peruviana* are both inhabitants of the lower slopes. After crossing the Carpis range, Mr. Pritchett followed the course of the river of Casapi to the village of Chinchao, and went thence to the coca estate of Casapi at the eastern end of the valley, where it joins that of the river Huallaga, and here he was joined by his guide.

About three leagues from Casapi, and close to the Huallaga, is the mountain called San Cristoval de Cocheros (Cuchero of Pavon and Poeppig), which rises from the low land at the junction of the two rivers to a height of about 1200 feet above them, and is the centre of the bark district of Huanuco. On the northern side Mr. Pritchett found abundance of *C. micrantha*, and some trees of *C. Peruviana;* but the latter species was much more rare. They both grow to a very large size, some of them being thirty inches in diameter and seventy feet in height. The trees of *C. nitida* were at a higher elevation.

During June and July, though it was the dry season, heavy rains continued to fall from day to day; but towards the end of July the weather broke up, and the sun began to make an impression on the solid banks of cloud which filled the valleys, and then it was that, during some portion of the day, the sun penetrated to the very underwood of the forest. In the first half of August there was fine weather, with only an occasional shower. The seeds on the chinchona trees ripened rapidly in the sunshine, and Mr. Pritchett collected

them by felling the trees—a labour which was performed by Indians, whom he hired from the coca estate of Casapi. Seven large trees were cut down daily for a fortnight, and denuded of their capsules; the drying process being carried on at the estate, where every moment of sunshine was taken advantage of. On the 13th of August he started for the coast with his collection of seeds, and half a mule-load of young chinchona plants, which were in perfect health when placed in the Wardian cases at Lima.

Mr. Pritchett reported that in the districts around Cocheros, Casapi, and Carpis, the rocks are of crystalline formation, in many localities highly disintegrated, and composed of masses of hornblende, felspar, and mica. He remarked that felspar contains much potash, of which the chinchona trees are said to require a large quantity for their full development; and, as felspar abounds in this region, he attributed the abundance and size of the chinchona trees to this circumstance. He also reported that steatite, a silicate of magnesia and alumina, abounds in the vicinity of Huanuco.

He described the climate as moist and warm, and says that the difference in the degree of moisture and warmth between the lower slopes where the *C. micrantha* flourishes, and the higher parts of the mountains inhabited by the *C. nitida*, is very striking, while on the lower slopes the soil is much deeper and richer.* He reported the elevation of Cocheros above

* Letter from Mr. Pritchett to the Under Secretary of State for India, dated July 9, 1861.

the level of the sea to be about 4000 feet,* but he made no meteorological or other observations; and I think there can be no doubt that the elevation of that mountain is much greater than Mr. Pritchett supposes. I do not find any information on this point in Poeppig's travels; but the Huanuco region is quite a beaten track, and there are several accounts of it by modern travellers. Huanuco itself is 6300 feet above the sea;† the distance thence to the summit of the cuesta del Carpis, which is 8000 feet above the sea, is about twenty miles, and there is a descent on the other side into the valley of the Casapi of 2920 feet.‡ According to this account the village of Chinchao, in the Casapi valley, would have an elevation of about 5000 feet. From Chinchao to the foot of the Cocheros mountain is a distance of twenty-five miles down the Casapi valley,§ a gentle descent, with numerous cottages and plantations on both sides of the road.‖ Thus the foot of the Cocheros mountain would be about 4500 feet above the sea, and its summit at least 6000 feet.

* Letter from Mr. Pritchett to the Under Secretary of State for India, dated December 13, 1860.

† Smyth's *Journey from Lima to Para*, p. 63.

‡ Herndon's *Valley of the Amazon*, p. 126.

§ *Ibid.*, p. 136.

‖ Smyth, p. 115; who says that, according to a register which had been kept there, it rains at Casapi on more than half the days of the year.

"From May to November the sun shines very powerfully in the valley of Chinchao, and consequently the soil, when it is cleared of wood, becomes so parched that its surface opens in chinks, but underneath it always preserves humidity, and therefore needs no irrigation. From November to May it rains much, sometimes six or seven days without intermission."—Dr. A. Smith's *Peru as It Is*, ii. p. 57.

We shall not, therefore, be very far from the truth if we place the region of *C. nitida* on the Cocheros and Carpis mountains at from 6000 to 7000 feet above the sea, and of *C. micrantha* at from 4000 to 5000 feet.

Mr. Prichett performed the portion of this important undertaking which I intrusted to him with promptitude and zeal. Time was a great object, and by going direct from Lima to the best locality in the Huanuco chinchona region, he completed the necessary collection of plants and seeds, and returned to the coast in little more than three months.* This shows how essential a previous knowledge of the chinchona region, of the people, and of the language, was, without which the collector would probably lose much time, which is the same thing as spending much money, and eventually wander into a locality where only worthless species are found.

* Of the identity of the species collected by Mr. Pritchett there is no doubt. He brought home specimens from the trees whence the seeds were obtained, which have been examined by Mr. Howard, and proved to belong to *C. nitida*, *C. micrantha*, and *C. Peruviana*. The barks also have been found to contain a satisfactory percentage of alkaloids. Some further particulars respecting these species have already been given in chap. vii. p. 57.

CHAPTER XXII.

MR. CROSS'S EXPEDITION TO PROCURE PLANTS AND SEEDS OF THE *C. OFFICINALIS* YIELDING CROWN BARKS IN THE FORESTS OF LOXA.

As soon as the work of 1860 was completed, I at once took steps to obtain those valuable species which had not been provided for in the sanctioned arrangements for that year. First in importance were the crown barks of Loxa, and I secured the services of Mr. Cross for the important duty of collecting this species. To his qualifications as a practical gardener he had now, under the instruction of Dr. Spruce, added a knowledge of the country and of the language, and he had shown himself to be an able, daring, and persevering explorer. I therefore selected him, in full confidence that he would carry out my instructions well and thoroughly.

Mr. Cross proceeded to South America in the autumn of 1861. On the 17th of September he left Guayaquil in an open rowing boat, and landed at Santa Rosa, the port of the province of Loxa, whence he proceeded by way of Zaruma to the town of Loxa, which he reached on the 27th. He had to pass through dense swampy forests, and over dangerous precipitous ridges of the

Andes, in crossing one of which his mule slipped down a deep ravine, and was dashed to pieces. He mentioned that during the ascent to Zaruma he saw several "red bark" trees growing at an elevation of 8000 feet.

On the 1st of October, Mr. Cross left Loxa, and went to a long low ridge of lias called the Sierra de Cajanuma, about eight miles to the southward, a locality which is mentioned by Humboldt, Bonpland, and Caldas as the abode of the most valuable kinds of *C. officinalis*. He came to an Indian hut on a little rounded eminence near the summit of the mountain, which, being far from public roads or other dwellings, seemed well suited for his head-quarters during the time that he was searching for seeds. For be it remembered that the Decree of May 1st, 1861, already mentioned, was in full force, and that he was running the risk of fine and imprisonment in performing this important service. The owner of the hut, who was an experienced bark collector, allowed Mr. Cross to establish himself in a little shed at one end of it, which, although favourable for drying seeds, was so cold that he was sometimes compelled, during windy nights, to seek shelter in the bottom of a neighbouring ravine.

After many comparatively unsuccessful searches in the surrounding woods, he was one day passing along the bank of a steep ravine, and happening to look over a projecting rock, he saw a number of fine young trees of the *C. officinalis* on the steep slope beneath, some of which bore a few panicles of seeds, which on examination he found to be perfectly ripe. After this discovery he

continued to search all the ravines in the vicinity from sunrise to sunset, some of which he had to descend by means of the trailing stems of a species of *Passiflora*, and in this way a good supply of seeds was collected. He reported that on the accessible slopes there are few chinchona trees, owing partly to the annual burning, and partly to continual cropping of the young shoots by cattle. He described the rocks, composed of micaceous schist and gneiss, as being, in many places, in a state of decomposition, and stated that large portions are frequently tumbling down from the more elevated summits. The alluvial deposit in the ravines, where the *C. officinalis* is found growing, is shallow, in many places not more than six inches in depth, and Mr. Cross often gathered seeds from trees which were growing in clefts of rocks, where there was not a single ounce of soil to be found. He described the *C. officinalis* as a slender tree, from 20 to 30 feet in height,* and from 8 to 10 inches in diameter at the base; but he saw few trees of these dimensions, and the plants from which the bark of commerce is now taken are in general not more than 8 to 10 feet in height.† When the plants are cut down, three or four young shoots or suckers generally spring up, but this does not always happen, as some of the more industrious bark collectors frequently pull up the roots, and bark them also. The bark is taken from the smallest twigs, and thus the annual

* Pavon gives its height at from 18 to 24 feet, and 8 to 9 inches in diameter.

† They yield the *crown bark* of commerce.

growths are often taken, especially if they are strong. The plants are sometimes found growing in small clumps, and sometimes solitary, but always in dry situations.

The temperature of this region ranges, according to Humboldt and Caldas, from 41° to 72° Fahr., and according to Mr. Cross from 34° to 70° Fahr.; but he added that it seldom falls below 40°, and rarely rises above 65°; the mean range being from 45° to 60° Fahr. The climate of Loxa is very moist. The wet season commences in January and lasts until the end of April or middle of May; in June, July, and August there are heavy rains, accompanied by strong gales of wind; from September to January there is generally fine weather, but occasional showers of rain fall even at that time of year.*

The vegetation on the Sierra de Cajanuma is of a semi-arborescent character, but some of the higher summits are bare. In the bottoms of the ravines grow a species of *Alnus*, *Melastomæ*, *Peperomias*, palms, and two species of tree-ferns; and on the slopes throughout the low-lying country, barley, maize, peas, and potatoes are cultivated. Mr. Cross sent home a large collection of dried specimens of plants gathered on the Sierra de Cajanuma. Among them I observed a *Befaria* with pretty crimson flowers, of which he says that one ounce of the roots in two pints of water is taken twice a day

* Seemann's *Voyage of H.M.S. Herald*, i. p. 177. For some further particulars respecting the chinchona region of Loxa, see chap. vii. pp. 36 to 41.

by the Indians for dysentery; a very handsome purple lupin, growing six to eight feet high; an *Embothrium,* a

CHINCHONA CHAHUARGUERA.

(From Howard's *Nueva Quinologia de Pavon.*)

wide-spreading shrub, growing in dry situations; another smaller *Befaria,* a beautiful shrub, growing

in very lofty dry localities; a *Veronica*, a shrub six to eight feet high, with a blue flower; a *Gaultheria;* a wide-spreading melastomaceous plant, with inconspicuous flowers; and a number of *Lycopodia* and ferns.

Besides the seeds of the *C. officinalis,* which is identical with the *C. Chahuarguera* (Pavon), Mr. Cross succeeded in collecting a few seeds of *C. crispa* (Tafalla) after several long journeys up the mountains. He found this kind growing at a great elevation, in a deposit of peat, where the temperature sometimes falls to 27° Fahr. This species of chinchona yields the *cascarilla crespilla negra,* one of the most esteemed forms of Loxa bark. Mr. Howard * mentions that the *Josephiana* bears the same relation to the normal *C. Calisaya* as the *Crespilla* bark at Loxa does to the normal and full-grown *C. Chahuarguera.*

Mr. Cross did his work right well, and in December 1861 he returned to Guayaquil with nearly 100,000 seeds of *C. officinalis* of two varieties, besides a smaller parcel of the variety called *C. crispa.*†

* *Nueva Quinologia de Pavon. C. Chahuarguera* and *C. crispa.*

† Mr. Cross transmitted the following dried specimens of the parts of chinchona trees from Loxa:—

1. Very characteristic specimens of the bark, leaves, flowers, and capsules of *C. officinalis* (*C. Chahuarguera*, Pavon). This kind yields the rusty crown bark of commerce.

2. Bark, leaves, and flowers of *C. crispa* (Tafalla), a kind which is included in the *C. officinalis*, H. and B. It yields the *quina fina de Loxa*, or *cascarilla crespilla.*

3. Bark and leaves of *C. Lucumæfolia* of Pavon, from Zamora. This is the *cascarilla de hoja de lucma* of the natives. Mr. Cross made no attempt to collect the seeds, as this species is comparatively worthless.

CHAPTER XXIII.

MR. CROSS'S EXPEDITIONS TO PROCURE PLANTS AND SEEDS OF THE COLOMBIAN BARK SPECIES.

HAVING obtained a supply of *C. officinalis* from the Loxa forests, it now only remained to secure the valuable kinds which were known to exist in the Republic of Colombia.

The species originally described by Mutis were, with the exception of his *C. lancifolia* and *C. cordifolia*, of no value. His other five species are not chinchonæ, but belong to allied genera. Still there are species of very great value in Colombia, namely, the *C. Pitayensis*, yielding quinidine, the Calisaya de Santa Fé, or soft Colombian bark, a variety of *C. lancifolia*, and the Carthagena bark from *C. cordifolia;* and of late years this Republic has become a principal source of quinine supply.

I accordingly made arrangements for obtaining seeds of the valuable species growing in the forests of Pitayo, in the State of Cauca, the most southern State of Colombia, bordering on Ecuador. Mr. Cross's success in the Loxa forests, and his admirable qualities as an explorer, pointed him out as the best man for this

very difficult work, and I again secured his services. He was then residing on the western slopes of Mount Chimborazo, whence he set out on his important mission in May 1863.

The first writer who described the country round Popayan and Pitayo was the Spanish *Conquistador* Cieza de Leon. He accompanied the invading discoverers who, starting from Darien in 1536, ascended the valley of the Cauca, and reached Popayan. I translated and edited his charming *Cronica* in 1864, and it was printed for the Hakluyt Society.* The next author who treated of this region was the humane and generous, but unfortunate Adelantado Andagoya, who was in Popayan in 1544. His narrative, which I have also translated and edited,† will be found amongst the collections of Navarrete. Ulloa, in his travels, gives a brief account of the province of Popayan; but the only modern writers who have preceded Cross are Humboldt, Caldas, Karsten, and Vigne. Humboldt crossed the *paramo* of Quindiu, ascended the valley of the Cauca to Popayan in 1801, and went thence to Pasto and Quito. During his stay at Popayan he made an excursion to the village of Puracé. The learned Caldas was a native of Popayan, and he and Mr. Vigne are the only writers who have gone over the same

* *The Travels of Pedro de Cieza de Leon*, A.D. 1532–50, *contained in the first part of his Chronicle of Peru. Translated and edited, with notes and an introduction, by Clements R. Markham.* (Hakluyt Society, 1864.)

† *Narrative of the Proceedings of Pedrarias Davila, written by the Adelantado Pascual de Andagoya. Translated and edited, with notes and an introduction, by Clements R. Markham.* (London, 1865.)

ground as Cross. None have given any account of the actual Pitayo forests.

Popayan is situated in the beautiful valley of Cauca, at the foot of the great volcanoes of Puracé and Sotara, in 2° 26′ 17″ north latitude, and 5800 feet above the sea. From this city Cross travelled eastward to the village of Sylvia, the head-quarters of the bark collectors. Some miles to the eastward of Sylvia a forest-covered ridge of lofty hills runs north and south, and from their western slopes branch spurs of lesser altitude, which gradually subside to the westward, until they become low green undulations on the edge of the Cauca valley. Near Sylvia are the villages of Totoro and Puracé, at the base of a forest-covered slope, from the crest of which rises the snow-covered Puracé volcano.*

On July 15th Cross left Sylvia and ascended the forest-covered Piñon de Pitayo to the eastward, which is 8000 feet above the sea. Here he found the chinchona trees growing in ravines on either side of the road. Descending the eastern slopes he reached the village of Pitayo, in a circular valley surrounded by high conical hills, on the summits of which are bare grassy *paramos*. He was informed at Pitayo that most of the trees had been felled, and that only two of any size remained in the Pitayo region, the property of two Indians. He immediately set out for the abode of one of these men, on

* This volcano was visited by Humboldt in November 1801. Puracé is celebrated for the beautiful cataracts of the river *Pusambio*, figured in Humboldt's *Vue des Cordillères*.

a hill slope above the village, and found four young trees laden with capsules. He thus succeeded in obtaining 450 ripened capsules full of seeds; and he made a further collection during excursions into the forests from the village of Sylvia. He then set out for Bogotá, the capital of the Republic of Colombia, which place he reached, after a difficult journey, on the 16th of September. Unfortunately his instructions did not reach Bogotá until October 14th, and in their absence he determined to retrace his steps to Quito, and despatch the seeds from the port of Guayaquil. These long journeys were fatal, and the seeds did not germinate.

Though Mr. Cross was prostrated by ague after his first Pitayo expedition, he returned to England in January 1867, quite ready to make a second attempt. But I considered that he should not again enter the forests until he had quite recovered his health. I therefore deferred the arrangements for his second expedition until 1868, and, owing to my absence with the Abyssinian expedition, Mr. Howard kindly drew up instructions for his guidance. He was to go out by way of Panama to the Pitayo forests, and to give his attention to the collection of seeds, and, if possible, also of small plants of all the species from Pitayo which have been found useful in commerce. Mr. Cross reached Panama on May 9th, 1868, went thence by steamer to Buenaventura on the west coast, and on the 14th of June he was again at the village of Sylvia, in the centre of the Pitayo region. He made such good use of his ....

time, that by the 22nd he had despatched two packets of chinchona seeds, by way of Bogotá.

From Sylvia Mr. Cross made his way to Pitayo, and thence followed a ravine in a north-easterly direction to the village of Hambalo, a distance of twelve miles. The mountains to the eastward rise up to the lofty and extensive *paramo* of Moras, part of a vast series of grassy mountains and volcanic peaks, which form a grandly picturesque part of the central cordillera. Dr. Spruce made numerous excursions in the neighbourhood of Ambalo, Pitayo, and Sylvia during the following months; and he reported the upper limit of the chinchona plant in this region to be 9700 feet. He was busily engaged in the collection of plants, and made valuable observations respecting their habitat, and the climate of this part of the cordillera, until, in October, he was prostrated by fever. As soon as he recovered he got four cases made, weighing 39 lbs. each, in which he established 270 plants. In January 1870, amidst torrents of tropical rain, Cross set out for the coast, accompanied by two faithful and intelligent lads from the Popayan valley, named Rafael and Benino Carbajal. The journey was a most trying and difficult one, but all obstacles were overcome, and on February 16th Mr. Cross embarked with his plants at Buenaventura. The collection of seeds had been sent previously in fifty-five packets, to despatch which Mr. Cross had made fourteen journeys from Sylvia to Popayan and back, an aggregate of 672 miles, exclusive of journeys in search of the seeds.

Mr. Cross reported that there are three distinct kinds of Pitayo barks, namely, the *yellow barks*, the *red Piñon barks*, and the *Piñon amarilla fina*. He said that the trees were being rapidly extirpated, and that no large ones could be found. The Pitayo climate exactly resembles that of the Loxa chinchona forests.

Through the admirable work of this most zealous and able collector, a good supply of plants and seeds of *C. Pitayensis* was thus secured, and introduced into India. It only remained to obtain the *Calisaya de Santa Fé*, plants yielding the *soft Colombian* barks, and the *C. cordifolia* yielding *Carthagena* barks, which would complete the enterprise. All the valuable kinds known to commerce would then have been introduced into India.

For the performance of this final work I again, for the fifth time, secured the services of Mr. Cross. He left England on this duty in August 1877, and going by way of Panama and Buenaventura, he arrived at Popayan on the 18th of September. Thence he went southwards to the town of San Sebastian, and, crossing the eastern cordillera, he entered the basin of the river Caquetá or Japura, a great affluent of the Amazon. The forests of the Caquetá produce the best description of soft Colombian bark. Mr. Cross left San Sebastian on October 4th, and commenced the ascent of the ridge of the eastern cordillera. He was accompanied by a lad who had previously assisted him in the Pitayo country, and by two Indians, carrying with them provisions for eighteen days. They reached the summit,

at a height of 13,300 feet above the sea, whence there was a wide view over the basin of the Caquetá to the eastward, with a series of winding ridges covered with a dense green mass of vegetation.

The little party then descended the eastern slope, following a gurgling rivulet, which the Indians declared to be the beginning of the river Caquetá. The rivulet at the base of the mountain was increased in volume by the addition of a number of streamlets from different directions.

After descending for an hour over broken ground they entered the forest, which was so thick and lofty that absolutely no sky could be seen during the two following days' journey. On each side of the path, which was only about three feet wide and ankle deep with mud, were thickets of prickly bushes and palms furnished with numerous straight delicate spines. There were a few spots of rising ground partially clear of underwood. The excellent deep rich mould of such localities was just the description of soil where quinine trees may be seen to grow most luxuriantly. The region on which they had now entered embraces an extensive portion of the slopes and lower lands of the eastern cordillera, and is usually termed the territory of the Caquetá. The chief part of it is unexplored and unknown. The bark tree is confined to the more elevated portion, inhabiting the cold, moist, humid forests from 7000 to 10,500 feet above the sea.

The only habitations met with are those of temporary sojourners' ranchos or bark sheds, which may be put

up to-day and abandoned a few days hence. All the Indian tribes inhabit the foot of the mountains in warm valleys, where Indian corn and mandioc can be grown, and where there is an abundance of fish in the rivers.

At mid-day Mr. Cross and his party emerged from the forest on to an open swampy place called the *paramillo*, which was soon found to be a sort of trembling bog, moving at every step, and with some difficulty they succeeded in getting across, all afraid of sinking through the thin surface of grassy turf which covered the soft mud beneath. More of these bogs were met with afterwards. The Indians, now that they had entered the shady forest wherein they had been accustomed to travel and roam about all their lives, proceeded more rapidly than they had done before. Notwithstanding the mud holes which had to be waded, and the falls which they as well as the lad and Mr. Cross frequently sustained, they were travelling at the rate of three miles an hour. The Indians on falling were up again in a moment, and pursuing the way with unabated speed. Although now well within the limits of the bark district, yet no bark plants were to be seen. There had been so many "resacadas" (re-collectings) that not a single stump or sapling seemed to have escaped. It was therefore necessary to continue the journey to a more remote locality, where the forest had not been so rigorously searched.

At sunset they came to an open spot called Las Animas, close to the bank of the Caquetá river, along

which they had travelled most of the day. The elevation was 9000 feet, and they remained here for the night. Before daylight on the morning of the 6th of October the Indians had a large blazing fire kindled, in order that they might have breakfast and be ready to travel the moment there was light enough to do so. This was the course followed while in the forests. The whole of the day was devoted to travelling or working, while cooking or eating had to be done after dusk or before daybreak. Continuing their journey, the path gradually became better. There were also fewer swampy places, and the forest trees were of more massive dimensions. The deposit was of soft yellow clayey loam of great depth, covered by a surface layer of vegetable mould. Shortly after mid-day they came on a young sapling of soft Colombian bark growing quite close to the path, and a little farther on many more were discovered. From the very first it was evident that good plants would be difficult to find, as those seen were tall, drawn-up saplings, with long bare tap-roots.

They were now on the brow of a hill, and the roughly-opened paths of the *cascarilleros* were seen running through the forest in every direction. A long descent then led down to the river Caquetá, which was reached at four in the afternoon, and they at once formed an encampment on the northern bank. By dismantling various abandoned *ranchos* they were enabled to build a tolerably commodious place for sleeping in. The Caquetá here was a large powerful

river twelve yards broad, with high steep banks and occasional cliffs on each side. The deep bed was strewn with enormous masses of grey granite, over which the river foamed and boiled in the most restless manner. Large as were those granite boulders, they were being gradually rolled downwards by the irresistible force of the torrent, occasionally striking against each other, and producing a dull, loud report. The elevation was found to be 7800 feet. A journey of only four hours more would have brought the party to a warm valley, inhabited by Indians, where traders embark in canoes to reach the river Amazon.

On the 8th of October Mr. Cross succeeded in getting a good many plants. On the 9th, the Indians again went in search of plants, while the lad and Cross were occupied in dressing and packing those already collected. The plants were divided into two classes. All young plants not exceeding one foot in length were set apart. The remaining portion with stems from two to eight feet in length were cut down to the collar, and only the root piece was taken. In the evening there were about 1000 plants of both classes. These were packed in two large baskets which the Indians carried on their backs. The baskets being heaped up were bulky, but comparatively light. Everything was put in order during the evening, so that they might commence the return journey on the following day.

The soft Colombian bark tree is met with most frequently in the fertile portions of the forest where the

soil is mealy and dry. It grows too, but more sparingly, in stony situations with a thin covering of mould. The tree shoots up in general rather slender but to a great height, rising often above the majority of forest trees, and is recognised by the collectors at a distance on account of its elevated crown of compact branches clothed with glossy leaves of a deep green colour. All collectors agree in saying that many dead trees still standing are met with in the forest. But the land is in many places rather swampy. During the rainy season no doubt flat low-lying portions of forest land are sometimes inundated, or at least much soaked. Such circumstances would prove injurious to those valuable trees. But it is certain that, in favourable localities, they sometimes attain to a great size. The tree has peculiarities not possessed by any other quinine-producing species. The epidermis or outer bark resembles in appearance that of a beech tree, and does not crack or become fissured, so that there is not the continual wasting process going on by the separation of dry, hard scales or flakes of bark from the outer surface, as is commonly the case with most trees. Another important fact is that the bark in drying loses less in weight than any other sort of bark. On account of its soft friable texture it is easily reduced to a powder.

The bark collectors are mostly Indians, and inhabit the banks of streams or rivers which flow from the foot of the eastern cordillera, and afterwards fall into the various tributaries of the Amazon. When going in

search of bark they proceed to the summits of the neighbouring hills, where, on finding one or more trees, they erect a thatched roof of palm leaves, twelve or fourteen feet in height, underneath which is made a platform (*barbacoa*) of wicker-work. Over this the bark is spread, to a depth of five or six inches, and is turned and moved about frequently. From four to six moderate fires are lighted on the ground underneath, and kept constantly burning until the bark is dry, which is usually in the space of three or four days. When the quantity of bark collected during the excursion is small, the collector takes it home, and dries it on the loft immediately above the fireplace used for cooking. If at any time unsuccessful in finding bark, he is not much disconcerted, as the streams and rivers near his abode abound with fish, which, with mandioc or plantain, suffice for his daily wants.

A collector, on going in search of bark, is generally accompanied by his wife or one or two of his sons. They are usually absent eight or ten days, and on returning bring with them about six *arrobas* of dry bark. This they can sell at San Sebastian at the rate of £1 5*s*. per *arroba* of 25 lbs. On their return to the forest they frequently take with them a quantity of coca, salt, and a few other articles for disposal or barter, so that this is another source by which good profits are made from the journey. Of course it is only Indians born in and accustomed to those regions who can accommodate themselves to the hardships of wild forest life.

Respecting the general arborescent vegetation of the cold forests, a large proportion were of the glossy-leaved myrtle family and composites. Although the climate is proverbially damp, very few ferns were seen, but mosses clothed the trees everywhere.

The temperature in the shade, during their stay at the encampment, was as follows :—

	Morning.	Noon.	Night.
6th October . . .	—	—	60°
7th „	59°	62°	60°
8th „	58°	65°	59°
9th „	57°	64°	58°
10th „	58°	—	—

The native account was that it rained nearly all the year round. At the same time, the rains are more in the form of drizzly showers than heavy downfalls. Towards the end of February the rains commence, and last till the middle of September, though of course there are many little showers during the intervening months. Bark is collected more or less throughout the year, but probably least is gathered in July and August. Hailstorms sometimes occur of so severe a character that, according to a cascarillero, hardly a leaf is left on the trees. Not unfrequently thick masses of mist float upwards and overspread the forest-covered slopes, whilst dense bodies of white wool-like exhalations fill the deeper valleys for a brief period at dawn of day, but these do not form characteristics of the Caquetá climate. Its feature, for at least six months of the year, may rather be regarded as consisting mainly of successional wetting showers, with gleams of warm sunshine from

about eight in the morning until three in the afternoon. However, at times there are, even in the rainy season, days during which there is bright hot sunshine for four or five hours together. The climatic conditions of the bark districts of Pitayo and Loxa are similar to those of the soft Colombian region, only that the latter at the same or a higher elevation is felt to be milder, especially in the evenings, which is fully accounted for by the warm currents of air coming up from the Amazon valley.

At daybreak, on the morning of the 10th, Mr. Cross commenced his return journey.

The Indians were in good spirits, and travelled at fully their former rate of speed, but they much lamented the want of coca, as their last mouthful had been already chewed. They asked several parties of travelling Indians for a little, but all declared they had none, although it was easy to see that their mouths were crammed with the leaf. As yet Mr. Cross had taken no part in the endeavours to procure coca, but he soon began to see it would be to the interest of all if he could succeed in getting some. Above Las Animas they met two Paez Indians from San Sebastian, who were going down towards the Caquetá. Mr. Cross addressed the foremost of them on the matter, offering to give in exchange some *panela*. He said "No," but stopped and laid down his bag at a resting-place at hand. Mr. Cross obtained six "chewings" of coca, and gave in return more than three times the value in *panela* sugar. No sooner had the Indians filled their

mouths with coca—which they previously powdered with a little lime—than they commenced travelling with a vengeance. The lad and Mr. Cross had to go at a running trot to keep up with them. On reaching a pond of mud or water they spent no time in stepping carefully round the edge; on the contrary, they rushed straight through it, regardless of everything. At dusk they finished a long day's journey, but the path had improved much, and the weather was favourable.

Before noon of the 11th they crossed the summit of the cordillera. In the forest no one can travel twenty yards after dark, but they were now in the open country, where the footpath, winding down steep grassy slopes, is discernible, so it was resolved to continue the journey to San Sebastian.

Thus was successfully performed a journey occupying nine days on foot, through dense wet forests and over one of the most desperate footpaths in the world. All returned in tolerable condition, though every one suffered more or less from scratches and bruises.

The plants which, on the whole, had stood well the vicissitudes of the forest travelling, were packed in four boxes, so as to form two mule loads.

On the 18th of October Mr. Cross left San Sebastian, accompanied by the lad and an arriero, and Popayan was reached on the night of the 22nd October. Here Mr. Cross resolved to make an attempt to collect some plants of the Carthagena bark, growing on the border of the Magdalena valley, on the eastern declivities of the central cordillera. He was induced to take this

step by the large and increasing export of this sort which has been going on ever since the exhaustion of the Pitayo forests, and in justice to himself it must be stated that the collection of this bark was not included in the engagement he entered into for collecting the soft Colombian species.

In the beginning of January Mr. Cross made preparations for collecting a number of bark plants in the district of Magdalena. After some consideration and inquiry, he proposed to cross the great mountain range of the central cordillera, dividing the Cauca and Magdalena valleys, by the pass of Guanacas, to a place called Coralis, a bark collectors' resort, situated on the opposite side of the mountain ridge. He employed an Indian as a guide, who had been some time occupied in collecting bark at Coralis.

Proceeding on the 13th, the mountain summit, at an elevation of 11,500 feet, was passed in fine warm sunshine, this being the most favourable time for crossing during the whole year. Coralis was reached on the evening of the same day. The place is merely a *tambo*, or thatched shed by the wayside for the accommodation of travellers to pass the night, and is situated on the southern bank of the Ullucos river, at an elevation of 7000 feet. The whole scene around was formed of lofty cliffs and wet-dropping precipices, with waterspouts and streamlets coming down in every direction. These towering masses of rugged rocks rise up to a dizzy height, apparently 5000 feet, bearing a growth of foliaceous lichens, mosses, and wild flowering herbs and

plants. Dispersed in crevices a few saplings are observable, with shrubs of lesser growth. At the base the Ullucos rushes restlessly down through a series of profound depths, with high steep banks of clayey loam on each side, supporting a thick mass of climbers and forest trees. At a short distance, the course of the river was completely hidden from view by the luxuriant crowns of numerous palms and tree-ferns. The state of the atmosphere was densely humid and vaporous. On the 14th search was made for plants, but only eighteen sapling shoots, torn from the roots of trees formerly cut down, could be as yet obtained, and from this source also was collected the bark brought home for analysis. The barked stumps were more than twice the thickness of those which yielded the sample of soft Colombian from the Caquetá, although perhaps not any older. The forest was so wet, and the place so circumscribed with precipices and gullies, that little ground was gone over. This locality for some time past has been well searched by collectors, and, besides the first gatherings obtained by cutting down all trees met with, there has since been three "re-collectings," when the bark of every stump, root, or sapling met with has been pared off. The bark of the Coralis and Inza district, and southward about Pedregal and Tulmina, has been wrought for a long time. At present it is being collected to the northward about four or five miles distant, near some villages, where, until of late years, the forests, owing to the hostility of the Indians,

remained wholly untouched. The trees, however, in this locality are not so large, because the country is more open, and the climate is certainly drier than that of Coralis.

The temperature at Coralis during their brief stay was :—

	Morning.	Noon.	Night.
January 13th . . .	—	—	62°
„ 14th . . .	60°	66°	63°
„ 15th . . .	60°	—	—

From the foregoing remarks it will be evident that the collection of this Carthagena bark was a work both of hardship and peril.

The region of the Carthagena bark tree, situated to the eastward of Popayan, and embracing within its limits the great volcano Huila, stretches along the eastern slope of the central cordillera for about seventy miles, and extends eastward from the mountain summits to near the banks of the Magdalena. It is chiefly composed of a vast assemblage of mountain masses, divided by steep shelving ravines, in places more than a thousand feet in depth, into which are precipitated the numerous swollen rivulets that gush down from the adjoining cliffs and steeps. The summits of the rugged heights are usually treeless, the forest being mostly confined to sheltered slopes and banks of ravines.

This region is, without doubt, the great centre of the Carthagena bark tree, and it is also here where it is seen growing most abundantly.

The general height of the Carthagena bark tree is from 40 to 50 feet, with a diameter of 1½ to 2 feet.

On the 27th of January, 1878, having previously packed the plants, Mr. Cross commenced the homeward journey. The mule owner brought with him a strong lad as peon, to assist in loading and unloading the beasts, and other duties.

They rested a day at Cali, and on the 5th of February continued their course, reaching the point of embarkation on the Dagua on the 8th of February. Proceeding in a canoe the following morning, Mr. Cross went down the river to Buenaventura. The whole journey was one of peril, at least for the plants, on account of the numerous cascades and rapids which had to be descended. Arriving at the port, he commenced packing and securing the plants. Here Mr. Cross was attacked with fierce swamp fever on the afternoon of the 11th, but he was able to embark, and he had a suitable place granted for the plants on board the Pacific mail steamer, which left Buenaventura on the 14th, and reached Panama on the 16th February. Mr. Cross arrived in England a month later.

Thus was the whole enterprise of introducing all the valuable chinchona species from South America into India made complete in all its parts. My original plan was at length carried out in its entirety, and the species from the five regions whence the barks of commerce are derived were converted from a wild to a cultivated

state, and brought together in the plantations of British India, namely, the valuable species from—

I. The Calisaya Region of S. Peru and Bolivia, *yellow barks.* [*C. Calisaya.*]
II. The Huanuco Region, yielding *grey barks.* [*C. nitida, C. micrantha, C. Peruviana.*]
III. The Loxa Region, yielding *crown barks.* [*C. officinalis.*]
IV. The Limon Region, yielding *red barks.* [*C. succirubra.*]
V. The Pitayo and Caquetá Regions, yielding *Colombian barks.* [*C. Pitayensis, C. lancifolia.*]

The *C. Calisaya, C. officinalis* of Loxa, and *C. lancifolia* from Colombia are species rich in quinine. The *C. Pitayensis* from Colombia specially contains quinidine, the *C. succirubra* is rich in chinchonidine, and the *C. nitida, C. micrantha,* and *C. Peruviana* from the Huanuco region yield chinchonine. All these chinchona alkaloids, and not quinine alone, have febrifuge virtues; and it was, therefore, necessary to introduce the cultivation of all the plants which produce them into India.

PART II.

INTRODUCTION OF CHINCHONA PLANTS AND SEEDS INTO BRITISH INDIA.

CHAPTER I.

TRANSMISSION OF PLANTS AND SEEDS TO INDIA.

So far as the labours in South America were concerned, all obstacles and difficulties were overcome, and the objects of this great enterprise were fully attained. Plants and seeds of all chinchona species known to commerce were brought to the coast, and in every instance the plants were satisfactorily established in Wardian cases. Botanical specimens of all the species were also collected and brought to England, so that their identity was placed beyond the possibility of doubt.*

* My collection of dried specimens is deposited in the museum and herbarium at Kew. It consists of leaves, flowers, fruit, and bark of *C. Calisaya;* leaves and flowers of *C. micrantha;* leaves and fruit of *C. Caravayensis;* fruit of *Pimentelia glomerata;* and bark from the branches of almost every species of chinchona and allied genera in the Caravayan forests.

Dr. Spruce's collection of all the parts of *C. succirubra* is in the herbarium at Kew.

Mr. Pritchett's collection of leaves, fruit, and bark of *C. nitida,*

But in conveying these precious mule loads to the sea-coast and safely embarking them, only half the difficulties had been overcome. There was a long transit, and although there was not much reason for apprehension with regard to the seeds, the plants, in the absence of any provision for conveying them direct across the Pacific, had to undergo an ordeal of unprecedented duration.

The most important introduction of plants into India, by means of Wardian cases, previous to the arrival of the chinchonas, was that of the tea from China in 1849 and following years by Mr. Fortune. On those occasions the cases were strongly and coarsely made, the glass shades firmly fixed, and the glass itself thick, and glazed in pieces of moderate size. The frames were protected by a grating of iron wire, with a canvas covering capable of being unrolled so as to screen the plants from the direct rays of the sun, if necessary. The soil was not less than eight or ten inches deep, and kept down by cross-battens, and the plants were fairly established in it before starting. In 1849 Mr. Fortune sowed large quantities of seeds in the cases, between rows of young plants, which germinated on their way from China to India, and reached their destination in the Himalayas

C. micrantha, *C. Peruviana*, and *C. obovata*, is in the possession of Mr. Howard.

Mr. Cross's dried specimens of leaves, flowers, fruit, and bark of *C. officinalis* (*C. Chahuarguera* of Pavon), bark, leaves, and flowers of *C. crispa* of Tafalla, and bark and leaves of *C. Lucumæfolia*, are partly in my possession, partly in that of Mr. Howard, and partly in that of Mr. Veitch.

in good condition. Out of 250 tea plants, 215 arrived in perfect order.*

But it was an easy process to convey plants by the short voyage from China to Calcutta, when compared with the introduction of plants from the western coast of South America into India; and the performance of the latter feat, in the case of the chinchona plants under Mr. Cross's care, is undoubtedly the most extraordinary success of the kind that has yet been achieved.

A few remarks on the treatment of plants in Wardian cases were supplied to me by Mr. Weir and Mr. Cross, who acquired their experience in the voyages from South America to India; and by Mr. McIvor, who received the plants on the Nilgiri hills. The cases were filled with soil to a depth of nine to ten inches, in which the chinchonas were planted in rows, from the back to the front of the case. The distance from plant to plant was regulated by their size, but, in the case of their having much foliage, they should be rather wide apart, for the crowding of foliage is always injurious, and often brings on mildew or mould. After having been planted they were well watered, and shaded from the glare of the mid-day sun. On the surface, between each row of plants, a batten was placed, extending from the back to the front of the case, and held firmly down by two longer battens extending lengthwise. By this means the soil and plants are not disturbed in the operation of moving the cases. When the cases are finally closed, the soil should be in a medium state as

* See Fortune's *Tea Districts*, chap. xxi. p. 358–9.

regards moisture, and all dead foliage should be removed. The cases should be made as air-tight as possible by filling the seams with putty, and every precaution must be taken to preserve the plants from the slightest contact with salt water. Mr. McIvor strongly recommends that the cases should be furnished with a false bottom, raised about two or three inches above the true bottom, by bars of wood of the required thickness being nailed on the underside. The false bottoms should have holes bored in them at regular intervals, with a few broken pieces of pot and a layer of moss placed over them. He considers that the best sort of soil is formed of equal parts of leaf-mould, turfy loam, and sand, mixed in a dry state, and spread out and exposed to the action of the sun for a few days before being placed in the cases. During the voyage the plants should have plenty of light and air, one side of the case left open for two or three hours, morning and evening, during fine weather, when dead leaves should be picked off, and water administered to any plant which may require it. The soil should be turned up on the surface to the depth of about half an inch with a small pointed stick every three or four days, and always kept rough on the surface, so as to allow the air to circulate in the soil. This circulation of air is also facilitated by the false bottom. The action of the air on the soil keeps the roots in fine condition, and entirely prevents the formation of mildew and damp; but the principal object of the false bottom is to allow any excess of water to drain off into a place where it cannot *sour* the soil, and yet will not be lost.

Then, as the soil becomes dry above, the water will be attracted to it.

With the exception of the false bottom, all the above suggestions were carefully attended to by the gardeners who were in charge of the chinchona plants during the voyages to India. I caused thirty Wardian cases to be sent out to South America, 3 feet 2 inches long, 1 foot 10 inches broad, and 3 feet 2 inches high, with spare glasses, and all the necessary tools and materials, each case weighing, with soil and plants, a little over 3 cwt. Fifteen of the cases received the plants from Caravaya at Islay, and fifteen were sent to Guayaquil for Dr. Spruce's collection. I also had six cases made at Lima for the grey bark plants from Huanuco. The plants from Caravaya sailed from Islay on the 22nd of June, 1860, were conveyed across the Isthmus of Panama, and arrived at Southampton in August, when 207 plants were in a flourishing and healthy condition. But the intense heat of the Red Sea, where the thermometer ranged from 99° in the night to 107° in the daytime, was fatal to them, and they all eventually died at Utakamund. The cases containing the plants from Huanuco left Callao in September, and were also in a promising state when they reached England, but on their arrival in India they were all dead. The "red bark" collection, under the management of Mr. Cross, sailed from Guayaquil on January 2nd, 1861. They arrived in England in excellent order. At that season the climate of the Red Sea is much cooler, and, owing to this circumstance and to the intelligent watchfulness of

Mr. Cross, 463 plants of *C. succirubra* arrived in a healthy condition in India, and continued to thrive. The collection of seeds from Caravaya, for the transmission of which I made arrangements before leaving Sandia, did not arrive in India until 1865, when they germinated satisfactorily. The "grey bark" seeds from Huanuco arrived on the Nilgiri hills early in January 1861, and the "red bark" seeds in the following March, both collections coming up abundantly. In 1865 Mr. Charles Ledger obtained a large supply of chinchona seeds from the forests of Bolivia, and transmitted them to his brother in England for sale. Half the supply was bought by the Dutch Government for the Java plantations, and the other half by Mr. Money, an English planter in the Nilgiri hills. The supplies of seeds of *C. officinalis* from the Loxa forests reached their destinations in Southern India and Ceylon in February 1862, and germinated abundantly. Mr. Howard also presented a valuable plant of the *Uritusinga* variety of *C. officinalis* to the Indian plantations. It arrived safely, and many cuttings were taken from it and have thriven; but it was exposed to much danger in the transit, through carelessness.

The supply of seeds sent by Mr. Cross from the Pitayo forests, in 1863, did not germinate on account of the long delay in transmission. But the fifty-five packets of seeds which he transmitted from Popayan in 1869 arrived in India in a good state, and germinated freely. Mr. Cross came home himself with the plants of *C. Pitayensis*, arriving at Southampton on March 18th,

1870. The plants were deposited in the Royal Botanical Gardens at Kew, until the heat of the Red Sea was passed, and finally despatched to India in the following October.

Mr. Cross arrived at Southampton with his collection of plants of the Calisaya de Santa Fé (*C. lancifolia*) and Carthagena bark species on the 16th of March, 1878, and the plants were safely deposited at Kew. The root pieces of the Calisaya de Santa Fé, originally dug up in the Caquetá forests, would not root properly, but they pushed some shoots from which a number of cuttings were obtained; and sixteen plants were thus secured. Fifty plants were also obtained from the Carthagena bark collection of root stumps, so that both kinds will be introduced into India.

In the transit of these numerous relays of plants from South America to India, great assistance was derived from the Royal Botanical Gardens at Kew, where the plants were received and cared for, until they had recovered from the injurious effects of long journeys and voyages, and were fit to be sent on to India. Much of the final success is due to the care bestowed on the collections at Kew, and to the ever-ready aid and valuable advice of Sir William and afterwards of Sir Joseph Hooker.

CHAPTER II.

THE BENEFIT TO BRITISH INDIA HAS CAUSED NO DETRIMENT TO SOUTH AMERICA.

In obtaining plants and seeds of the valuable chinchonas from South America, it would have been a source of deep regret to me if that measure had been attended by any injury to the people or the commerce of Peru, Ecuador, or Colombia, countries in the welfare of which I have for many years taken the deepest interest. But I had no apprehension that such would be the result of the cultivation of these plants in other parts of the world. The demand for quinine will always be in excess of the supply from South America; and the cultivation of chinchona plants in India and Java will have the effect of lowering the price, and bringing this inestimable febrifuge within the reach of a vast number of people who are now excluded from its use, without in any way injuring the trade of Peru, Ecuador, or Colombia. I trust that not only will this measure do no injury to the South Americans, but that it may be hereafter productive of good to them, as well as to the rest of mankind. Hitherto they have destroyed the chinchona trees in a spirit of reckless short-sightedness, and thus done more injury to their

own interests than could possibly have arisen from any commercial competition; but it may be that the influence of peace and education will inaugurate a new system in time to come, that more enlightened views will prevail, and that they themselves may undertake the cultivation of a plant which is indigenous to their forests, but the conservancy of which, up to this time, they have so unwisely neglected. It will then be a pleasure to supply them with the information which will have been gained by the experience of cultivators in India, and thus to assist them in the establishment of plantations on the slopes of the eastern Andes.

Under any circumstances the South Americans, who owe to India the staple food of millions of their people, and to the Old World most of their valuable products—wheat, barley, rice, apples, peaches, sugar-cane, the vine, the olive, sheep, cattle and horses—should not desire to withhold from the people of India a product which is essential to their welfare. Nor have I any reason for believing that educated South Americans ever had any such desire. Numerous obstructions were thrown in my way by local officials in Caravaya and at the Islay Custom-house, but I made the collection of chinchona plants with the full permission of the Peruvian Government, and embarked the plants in accordance with the written orders of the Minister of Finance. It is untrue that I acted in defiance of the laws of the country, as has been stated more than once.* There

* Especially in an article in the *Calcutta Review*, which was full of misstatements.

was no Peruvian law prohibiting the exportation of chinchona plants and seeds; and I here print the written permission of the Peruvian Minister. It is as follows:—

"Ministerio de Hacienda y Comercio.
"Lima, Junio 20 de 1860.

"En el expediente relativa a la medida tomada por el Administrador de la Aduana de Islay, impediendo la extraccion de cierto numero de plantas de cascarilla, ha recaido con fecha de hoy, el siguiente decreto.

"Visto este expediente, y atendiendo a que no esta prohibida por reglamento de Comercio, la extraccion de plantas de cascarilla, y a que de impedirse su exportacion, con detrimento de la libertad comercial que las leyes de la Republica, y ese reglamento protejan, no se conseguiria en manera alguna el objeto que el Administrador de la Aduana se ha propuesto al impedir el embarque de varias plantas de esa especie, se desaprueba dicha prohibicion, sin que por este se entiende que el Gobierno deja de apreciar el celo y patriotismo que revela en el preindicado Administrador la enunciada medida.

"Dios guarda a V. S.,
"JUAN JOSÉ SALCEDO."

It is equally untrue that Dr. Spruce, in collecting the plants of *C. succirubra*, acted in defiance of the laws of Ecuador. At that time there was no law against the exportation of chinchona plants, although a decree to that effect was issued by the Ecuadorian Government on May 1st, 1861, several months *after* the collection of plants had been embarked.

I acted in the firm belief that the cultivation of chinchona plants in India would be very beneficial to Peru and the other Andean Republics, by gradually leading the people to imitate our example and cultivate the valuable trees which grow wild in their forests. This belief is shared by enlightened South Americans. Among them may be mentioned Señor Narciso Lorenzano of Bogotá, who in a letter to H.M. Consul-General, dated March 4th, 1864, said that he should always consider the chinchona plantations in British India to be of great use. Their success will lead to the adoption of a system of conservancy in the South American forests, and eventually to the formation of regular plantations.

In the hope of assisting in these desirable results, and of giving some return for the precious freights which I caused to be conveyed from the forests of the Andes, I have taken pains to furnish South Americans with information respecting the system of chinchona cultivation in India. With this object I wrote a pamphlet in the Spanish language, giving an account of the various methods and practices adopted in cultivating the chinchona trees in British India.* In this pamphlet I expressed the hope that the day would come when the slopes of the Andes would be covered with

* *Relacion de los resultados de los ensayos hechos en las Indias Britanicas sobre la cultivacion de los arboles de cascarilla importados de la America Meridional, por Don Clemente R. Markham. Para el uso de los proprietarios y cultivadores de plantacioncs en las montañas de Bolivia, el Peru, el Ecuador, y los Estados Unidos de Colombia.* (Londres, 1867, pp. 32, 8vo.)

chinchona plantations, carefully cultivated, from Bogotá to La Paz; and when the occupation of the wandering *cascarillero* would have been entirely replaced by that of the scientific cultivator.* The pamphlet was extensively distributed among persons likely to be interested in the subject, in Colombia, Ecuador, Peru, and Bolivia; and I know that it has proved useful in several instances, and that the good derived by British India from South America has, in some measure, been thus repaid.

* "El dia vendra, como lo espero, cuando los declivos de los Andes, desde Bogotá hasta La Paz, seran cubiertos de plantaciones de cascarilla, cuidadosamente cultivadas; y cuando la ocupacion del cascarillero errante será reemplazada por aquella del agricultor cientifico."

CHAPTER III.

THE INTRODUCERS OF CHINCHONA CULTIVATION INTO INDIA.

THEIR SERVICES AND THEIR RECOMPENSE.

THE introducers of chinchona cultivation into India undertook their perilous and most difficult tasks for remuneration that was little more than nominal. In several instances the actual expenses exceeded the whole grant for expenses and remuneration, leaving no margin; and in more than one case the performance of the duty entailed actual loss.

The system I adopted was, as I have already explained,* to include very slight remuneration in the original agreements. Thus the loss to Government would be insignificant if the work was not executed satisfactorily. If, on the other hand, the arduous tasks were successfully performed, the service would be so important, the benefits conferred on India so great, and the financial results so remunerative, that I anticipated no difficulty in obtaining fitting recognition for such distinguished services.

My fellow-labourers, Dr. Spruce, Mr. Pritchett, Mr. Cross, Mr. Weir, and Mr. Ledger, were all determined

* See page 95.

to perform the tasks intrusted to them thoroughly and faithfully, and possessed of special qualifications for their work. I am at a loss how to express my feeling of admiration for the way in which they executed the duties assigned to them, and of gratitude for their admirable service. Those feelings of admiration and of gratitude ought to be fully shared by the Government and the people of India, who have derived, and are deriving, so full a measure of profit and benefit from the sufferings and losses of those who did for India such hard and perilous service. This chapter contains a record of the recompense they have received.

After leaving the chinchona forests, Dr. Spruce was attacked by fever, with threatenings of paralysis. Having partially recovered, he prepared his elaborate and exhaustive report, for which he received the sum of £27. Before he had quite completed it, the illness contracted in the forests, in the service of the Secretary of State for India, came on again, and disabled him. The whole cost of collecting the plants and seeds of *C. succirubra*, which now yield to the Government an annual income of many thousands, was £857. This included Dr. Spruce's salary of £30 a month, and the payment of £27 for his report. When he returned to England in 1864, his health had been entirely destroyed in the service of India. I made an earnest appeal for recognition of his services in the shape of a small pension. This was refused.*

* In June 1865, Lord Palmerston, mainly through the kind intervention of the Earl of Carlisle and his sisters, granted Dr. Spruce a

When I went to India on a second mission in 1866, I thought that the value of Dr. Spruce's services would be better appreciated by those who resided in India, and knew what Indian fevers were. I therefore brought the case to the notice of the Government of Madras, with an appeal to them to recommend some special recognition of Dr. Spruce's services. But they merely transmitted my letter to the Secretary of State, without any recommendation, or even a word of comment, and again my appeal was rejected.

It must be clearly understood that Dr. Spruce's high sense of honour prevented him from making any representation himself on the subject, directly or indirectly. He undertook the work for a certain remuneration, and he never made a complaint or hinted at any expectation of further reward. The action I took was entirely on my own responsibility. Dr. Spruce went to live in his native village of Welburn in Yorkshire, and afterwards removed to Coneysthorpe, both near Castle Howard. After a time he was able to begin work on his vast collection of mosses and hepaticæ from the valley of the Amazons. But his infirmities only allowed of his working with pain and difficulty, each plant requiring microscopic examination. It was the labour of years.*

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pension of £50 a year for his distinguished services to botanical science; saying at the time that he could not do more, because Dr. Spruce's most important work was done for India, and should, therefore, be rewarded by the Government of India.

* In this place it will be well to give a list of Dr. Spruce's con-

As the most able and accomplished of my coadjutors, I felt it to be my duty to persevere in striving to obtain due recognition of his services. At length, in

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tributions to science. Some account of his work in South America will be found at pp. 98 and 99.

1. The Musci and Hepaticæ of Teesdale. *Ann. Nat. Hist.* xiii. pp. 192–203, 271–283; *Edin. Bot. Soc. Trans.* ii. p. 65–89 (1841).

2. On the Folia accessoria of Hypnum filicinum. *Phytologist*, i. p. 459 (1846).

3. On the branch-bearing leaves of Jungermannia juniperina. *Phytologist*, ii. p. 85 (1845).

4. A list of the Musci and Hepaticæ of Yorkshire. *Phytologist*, ii. p. 147 (1845).

5. On several Mosses new to the British Flora. *Hooker's Lond. Journ. Bot.* v. pp. 345–417, 535.

6. Notes on the Botany of the Pyrenees. *Ann. Nat. Hist.* iii. pp. 81, 269, 358, 478 (1849); iv. p. 104; *Edin. Bot. Soc. Trans.* iii. p. 103 (1850).

7. The Musci and Hepaticæ of the Pyrenees. *Ann. Nat. Hist.* iii. pp. 81, 267, 358, 478; iv. p. 104.

8. Botanical excursion on the Amazon. *Hooker's Journ. Bot.* ii. pp. 65, 178, 193, 225, 266, 298; iii. pp. 84, 139, 239, 270, 335; iv. p. 305 (1852).

9. Journal of a voyage up the Amazon and Rio Negro. *Hooker's Journ. Bot.* v. pp. 187, 207 (1853); vi. p. 33 (1854); vii. p. 1 (1855).

10. Botanical objects contributed to the Kew Museum from the Amazon river in 1851–53. *Hooker's Journ. Bot.* v. pp. 169, 238; vii. pp. 209, 245, 273.

11. Edible fruits of the Rio Negro. *Hooker's Journ. Bot.* v. p. 183 (1853).

12. Extracts of a letter relating to Vegetable Oils. *Hooker's Journ. Bot.* vi. p. 333 (1854).

13. Note on the India-rubber of the Amazon. *Hooker's Journ. Bot.* vii. p. 193 (1855); *Journ. de Pharm.* xxviii. p. 382.

14. On five new plants from Eastern Peru. *Linnean Soc. Journ.* iii. p. 191 (1859).

15. On Leopoldinia Piassaba. *Linnean Soc. Journ.* iv. p. 58, (1860).

16. Notes on a visit to the Chinchona forests on the western slopes of the Quitenian Andes. *Linnean Soc. Journ.* iv. p. 176.

1877, the Secretary of State for India granted a pension of £50 a year to Dr. Spruce. I represented that if Dr. Spruce was entitled to a pension at all, he was entitled to it from the time when the service was performed, and that it would be just to date the pension, not from 1877, but from 1864, the year of his return to England. The payment would not come from the tax-payers of India, but from the profits of his own work. For the "red bark" plants collected by

17. On the mountains of Llanganati in the eastern Cordillera of the Quitenian Andes. *R. G. S. Journ.* xxxi. p. 163.

18. On the mode of branching of some Amazon trees. *Linnean Soc. Journ.* (Bot.) v. p. 3.

19. Mosses of the Amazon and Andes. *Linnean Soc. Journ.* v. p. 105 (1861).

20. Note on the volcanic tufa of Latacunga at the foot of Cotopaxi, and on the Cangáua or volcanic mud of the Quitenian Andes. *Geol. Soc. Quart. Journ.* xxi. p. 249; *Phil. Mag.* xxix. p. 401 (1865).

21. Note on some insect and other migrations observed in Equatorial America. *Linnean Soc. Journ.* (Zool.) ix. p. 346 (1868).

22. On the fertilisation of Grasses. *American Naturalist*, iv. p. 239 (1871).

23. Palmæ Amazonicæ sive Enumeratio Palmarum in itinere suo per regiones Americæ æquatoriales lectarum. *Linnean Soc. Journ.* (Bot.) xi. pp. 65–183 (1871); *Botan. Zeitung*, xxvii. col. 664.

24. Zum geographischen Verständniss der Americanische Reisepflanzen. *Botan. Zeitung*, xxxi. col. 28 (1873).

25. Spruce and Correa de Mello. Notes on the Papayaceæ. *Linnean Soc. Journ.* (*Bot.*) x. p. 1 (1869).

26. Report on the expedition to procure seeds and plants of the Chinchona succirubra or red bark tree, dated Jan. 3rd, 1862. *Chinchona Blue Book*, i. p. 65 (1863).

27. Report on the valleys of Piura and Chira in Northern Peru. and on the cotton cultivation therein (1864).

28. On some remarkable Narcotics of the Amazon valley and Orinoco. *Geographical Magazine*, Aug. 1873, p. 184.

29. Personal experiences of Venomous Reptiles and Insects in South America. *Geographical Magazine*, July, 1873, p. 135.

Dr. Spruce annually put many thousands into the Indian treasury, and have saved many hundreds of lives. Yet a fair recompense has been persistently refused.

Mr. Pritchett, for collecting the chinchona plants and seeds in the forests of Huanuco, received £650 to cover all expenses, including salary.

Mr. Cross has been almost unceasingly at work since 1860. He served in the "red bark" forests with Dr. Spruce, and brought the plants to India. Secondly, he obtained seeds of the *C. officinalis* in the Loxa forests. Thirdly, he made a long and dangerous journey from near Quito to the Pitayo forests and to Bogotá. Fourthly, he again proceeded to the Pitayo forests near Popayan, collecting plants and seeds of a valuable species. Fifthly, I employed him on the Isthmus of Panama to collect plants of the *Castilloa*, yielding india-rubber. Sixthly, I sent him to Brazil, to obtain the *Hevea* and other caoutchouc yielding plants. Seventhly, he went for a third time to Colombia, to collect other chinchona species. He has done most valuable service with resolution and ability. He has encountered great dangers and suffered from repeated attacks of fever. The sums he has received have seldom more than covered his expenses, and by one of the expeditions he was a loser. Like Dr. Spruce, he is scrupulously careful never to claim a farthing beyond his original agreements. But his great services undoubtedly deserved special recognition. I considered that a grant of £200 for each of his five chinchona expeditions would be a very moderate recompense indeed. On his final

return to England in 1879, I accordingly applied for a grant to Mr. Cross of £1000 for the whole of his work connected with the introduction of chinchona cultivation into India. This was refused. He was granted £300. Subsequently the payment of another £300 to Mr. Cross was sanctioned. I made another appeal for justice to Mr. Cross. It was again rejected. Meanwhile the *C. officinalis* trees obtained by him are bringing in annual profits of thousands to the Government.

Mr. John Weir, the gardener who penetrated into the forests of Caravaya, and made a large and valuable collection of plants under my personal superintendence, did his work with great zeal and untiring perseverance. He was a most conscientious, active, and skilful worker, and, so far as his own labours were concerned, he was completely successful. He established the plants in the Wardian cases at Islay, and conveyed them to India. His small wages were wholly inadequate, but he never received any further reward or recognition of any kind.

On his return from India in January 1861, Weir was employed by the Horticultural Society, to proceed to South America for the purpose of collecting and introducing into England new plants of horticultural interest, first in South Brazil, and afterwards in Colombia. He introduced a considerable number of new plants, and made collections of dried specimens, many of them new to science.* Weir also undertook a commission for Mr.

* Some of them have been described by Mr. Weir in the *Proceedings* of the Royal Horticultural Society. A collection of mosses, made by Mr. Weir, was included by Mr. Mithen in his *Musci Austro-Americani*, a work published by the Linnean Society.

Daniel Hanbury, to procure for him specimens of plants yielding the balsam of tolu, and the Savanilla rhatany, and to note the methods of collecting these drugs. He performed this commission to Mr. Hanbury's entire satisfaction.

In October 1864, Weir embarked at Honda, on the Magdalena, on board one of the steamers plying on that river, with a large and valuable collection of plants, chiefly orchids, and among them many of the beautiful *Odontoglossum Alexandræ*, which has since in its numerous varieties become so popular in England. He hoped, by accompanying the collection to the coast, to save it from the delays which had proved fatal to former collections. At Barranquilla he transferred his plants to a boat, and hurried off to catch the English mail steamer at Santa Marta. On the way, and when still about twenty miles from the port, the land breeze failed, and he was obliged to put on shore and wait for wind. Knowing that he had but little time to spare, Weir determined to walk to Santa Marta, to secure a suitable place for unpacking and repacking his collection. Leaving his men to bring on the boat as quickly as possible, he started on foot. The way was over hot burning loose sand, in which his feet sank to the ankles at every step, and when dead tired he got drenched by a thunder-storm, just before reaching his destination. Next morning he had a violent headache, but, as the mail left that day, he set to work and got his plants properly packed and shipped. He then hurried back to Barranquilla to catch the return steamer up the

Magdalena, all the while suffering from headache, and unfortunately he again got drenched in a thunder-storm. Next morning he was in a high fever on board the steamer, the violent headache being followed by numbness and paralysis, so that he could move nothing but his head. He was suffering from severe inflammation of the spinal cord. He was put on shore at Honda, and was lying helpless in a native hut for a fortnight. A compassionate American, settled at Honda, then took the sufferer into his house, where he remained three months, unable to move hand or foot. At length he was put on board a steamer, and shipped to England, where he arrived in April 1865. His recovery has since been very partial, and he is crippled and disabled for life. The Fellows of the Horticultural Society subscribed about £600 for his benefit, the interest of which produces £27 a year. On this, and his wife's earnings, Weir has since subsisted, "making the best of a bad job," as he says. It is very grievous to see an able and promising collector, full of zeal and energy, thus struck down in the prime of life. While health lasted he worked conscientiously and bravely, and not the least important part of his services were those he performed in the forests of Caravaya, for the Government and people of India. I made an urgent appeal for some small grant in recognition of Weir's excellent and faithful services while under my orders. It was refused.

Mr. Charles Ledger did not serve under me; but as soon as he heard the purpose of my expedition to South

America, he endeavoured, though unsuccessfully, to open communication with me, and he set to work, actively and zealously, to co-operate in the good cause. He succeeded in obtaining a collection of seeds of a most valuable variety of *C. Calisaya*, which has been found to yield an extraordinarily large percentage of quinine. The plants from these seeds, since named *C. Ledgeriana*, have greatly increased the value of the chinchona plantations in the East Indies. The expenditure entailed upon Mr. Ledger in procuring the seeds very far exceeded the sum obtained by their sale, and he has lost heavily. He is now advanced in years, and residing in Tucuman, a distant part of South America. By the introduction of this rich variety, Mr. Ledger has done important service to the Government and people of India. I therefore urged that, as a recompense for this useful work, he should be granted the small sum of £200. My request was refused. I made a second appeal for some slight recognition of Mr. Ledger's services. My request was again refused.

In this history of the introduction of chinchona cultivation into India, I have considered it right to place on record the amount of recompense which has been received by or refused to the workers in the forests of South America. They have laboured zealously and most successfully, and their task was one which called for special qualifications. Some have lost health, all have risked life and limb in the service of their country. They have nobly earned the gratitude

of the Government and people of India. Chinchona cultivation is now not only self-supporting, but remunerative. Recompense would not be paid from revenue provided by the tax-payers of India, but from the profits of work actually done by the very men who are now deprived of their due reward.

It is unnecessary that I should give further expression to the indignation I feel at the injustice with which those have been treated who have done an inestimable service to mankind. If the people of England, and still more, the people of India, are contented that this should be the requital for such service, there is nothing more to be said.

PART III.

CHINCHONA CULTIVATION IN INDIA.

CHAPTER I.

SELECTION OF THE FIRST SITE.

THE selection of the best site in India for commencing the experiment of introducing chinchona cultivation was a point of great importance. Upon a right decision the success of the enterprise, in this stage, mainly depended. It was necessary to ascertain the position in India which most nearly resembled the chinchona forests of South America as regards latitude, altitude, climate, and soil. From this position, as a centre, I hoped that the cultivation might eventually spread over a much larger area, and be successful, with the aid of scientific skill and care, in many places which are not so analogous to the native habitat of the plants.

India presents a great variety of climates. There is one arid region, with a normal rainfall of less than fifteen inches, occupying a large portion of the north-west corner of India, from the salt range to the mouths of the Indus, and from the Suleiman mountains to the

By Trelawny Saunders, Geogr

A MAP OF INDIA WITH THE CHINCHONA PLANTATIONS AND THE LINES OF RAINFALL.

Scale of English Statute Miles. 100 0 100 200 300

TURKISTAN
CHINESE EMPIRE
AFGHANISTAN
BALUCHISTAN
PUNJAB
RAJPUTANA
Sind
NORTH WESTERN PROVINCES
OUDE
CENTRAL INDIA
BERAR PROVINCES
THE DECCAN
HAIDARABAD
MYSORE
MADRAS PRESIDENCY
BOMBAY PRESIDENCY
BHUTAN
BURMAH
ARABIAN SEA
BAY OF BENGAL
Laccadive Islands
Maldive Islands
Andaman Islands
Nicobar Islands
CEYLON
Gobi or Great Desert
Plateau of Tibet
The Punjab
The Thur or Indian Desert
Kattywar
Plain of Gurzerat
Plateau of Malwa
Plain of Chuteesgurh
Mouths of the Indus
Mouths of the Ganges
Mouths of the Mahanuddy
Mouths of the Godavery
Mouths of the Kistnah
Mouths of the Irawaddy
C. Comorin
C. Negrais
Cape Negrais
Northern Ghauts
Western Ghauts
Eastern Ghauts
Vindhya Mts
Satpoora Mts
Aravalli Mts
Himalaya Mts
Hindoo Koosh Mts
Kuen Lun Mts
Thian Shan Mts
Sulieman Mts
Bolor Tagh Mts
Karakoram Mts
Kong Mts
Pegu Yoma Mts
Arracan Mts
Pulney Hills
Anamalle Hills
Nilagiri Hills
Cardamum Hills
Shevaroy Hills
Coorg Hills
Cherra Poonjee Hills
Khasya Hills
Karen Hills
Tenasserim Mts
Lob Nor
Tarim Kul
Koko Nor
Sources of Yangtse Kiang R.
Sources of Yellow R.
Teng'ri Nor L.
Pulicat L.
Kaveri R.
Indus R.
Ganges R.
Sutlej R.
Jumna R.
Nerbudda R.
Tapee R.
Godavery R.
Kistnah R.
Irawaddy R.
Salween R.
Menam R.
Mekong R.
Yang-tse-kiang R.
Hoang-ho R.
Brahmapootra R.
Kyendwen R.
Yoma Mts
Victoria L.
Yarkand
Kashgar
Kokan
Bokhara
Balkh
Cabool
Peshawur
Leh
Khotan
Lassa
Batang
Tali-fu
Bamo
Manoelay
Rangoon
Moulmein
Tongkoo
Takau Ferry
Bombay
Surat
Goa
Mangalore
Madura
Trichinopoly
Calicut
Cannanore
Palghat
Jog or Cow Flower
Mahabaleshwar Hills
Ratnagiri
Nagpur
Nagpoor
Jubbulpore
Allahabad
Agra
Lucknow
Delhi
Simla
Kotgurh
Deyra Dhoon
Roorkee
Meerut
Umballa
Loodiana
Ferozepore
Lahore
Peshawur
Attock
Jellalabad
Candy
Newera-ellia
Colombo
Pt de Galle
Haidarabad
Calcutta
Madras
Mysore
Seringapatam
Bangalore
Neilgherry Hills
Paramahl Hills
Sherapore Hills
Garrow Hills
Jynteah Hills
Cossyah Hills
Naga Hills
Patkoi Mts
Chittagong
Akyab
Prome
Ava
Amherst
Tavoy
Mergui
Junkseylon
Penang
Malacca
Singapore
Sumatra
Java
Borneo
Celebes
Timor
Hainan
Formosa
Canton
Macao
Hong Kong
Amoy
Foochow
Ningpo
Shanghai
Nankin
Pekin
Yeddo
Nagasaki
Japan
Corea
Gulf of Cambay
Gulf of Martaban
Gulf of Siam
Gulf of Tonquin
Yellow Sea
Sea of Japan
Pacific Ocean
Sea of Okhotsk
Behring's Straits
Kamtschatka
Aral Sea
Caspian Sea
Black Sea
Persia
Arabia
Red Sea
Abyssinia
Africa
Europe
Asia
America
Australia
Russia
Siberia
Tartary
Mongolia
Turkey
Egypt
Nubia
Sahara
Soudan
Guinea
Cape of Good Hope
Madagascar
Mauritius
Bourbon
Socotra
Aden
Muscat
Ormuz
Bussorah
Bagdad
Mosul
Erzeroum
Trebizond
Constantinople
Smyrna
Malta
Gibraltar
Lisbon
Madrid
Paris
London
Berlin
Vienna
Petersburg
Moscow
Stockholm
Copenhagen
Rome
Naples
Venice
Marseilles
Algiers
Tripoli
Tunis
Fez
Morocco
Timbuctoo
Cape Verd Islands
Canary Islands
Azores
Madeira
St Helena
Ascension
Falkland Islands
Cape Horn
Magellan Straits
Patagonia
Chili
Peru
Bolivia
Brazil
Paraguay
Uruguay
Buenos Ayres
Rio Janeiro
Montevideo
Valparaiso
Lima
Panama
Isthmus of Darien
Gulf of Mexico
Mexico
California
Texas
Florida
Cuba
Jamaica
Hayti
Porto Rico
Trinidad
Barbadoes
Bermudas
Bahamas
Newfoundland
Labrador
Hudson's Bay
Canada
Nova Scotia
New Brunswick
Prince Edward Island
Quebec
Ontario
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
Niagara Falls
Boston
New York
Philadelphia
Washington
Baltimore
Charleston
Savannah
New Orleans
Mobile
Pensacola
Galveston
Vera Cruz
Acapulco
San Francisco
Sandwich Islands
Society Islands
Marquesas Islands
Navigator Islands
Friendly Islands
Fiji Islands
New Caledonia
New Zealand
New Holland
Van Diemen's Land
Port Jackson
Swan River
Torres Straits
Gulf of Carpentaria
Arafura Sea
Timor Sea
Coral Sea
Tasman Sea
Banda Sea
Molucca Passage
Celebes Sea
Java Sea
Sulu Sea
China Sea
Gulf of Tonquin
Gulf of Siam
Gulf of Martaban
Bay of Bengal
Arabian Sea
Indian Ocean
Atlantic Ocean
Pacific Ocean
Mediterranean Sea
Red Sea
Persian Gulf
Caspian Sea
Black Sea
Aral Sea
Sea of Azof
Baltic Sea
North Sea
English Channel
Irish Sea
Bay of Biscay
Gulf of Lyons
Adriatic Sea
Gulf of Venice
Archipelago
Sea of Marmora
Gulf of Finland
Gulf of Bothnia
Gulf of Riga
Gulf of Archangel
Gulf of Obi
Gulf of Penzinsk
Gulf of Anadir
Gulf of Alaska
Gulf of California
Gulf of Mexico
Gulf of Darien
Gulf of Guinea
Gulf of Aden
Gulf of Cambay
Gulf of Kutch
Gulf of Manaar
Gulf of Siam
Gulf of Tonquin
Gulf of Martaban
Gulf of Carpentaria
Gulf of Alaska
Gulf of California
Gulf of Mexico
Gulf of Darien
Gulf of Guinea
Gulf of Aden
Gulf of Cambay
Gulf of Kutch
Gulf of Manaar
Gulf of Siam
Gulf of Tonquin
Gulf of Martaban
Gulf of Carpentaria

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Aravallis. It includes the southern portion of the Punjab, Sindh, and part of Rajputana. There are also two zones of dry country, one surrounding this arid region in a belt from 100 to 200 miles wide; the other comprising part of the Dakhin and Mysor, and extending south, down the centre of the peninsula, to Cape Comorin. These dry belts have a rainfall of from 15 to 30 inches; while beyond them, over the rest of India, the normal fall exceeds 30 inches. But thriving forests are only found where the fall exceeds 40 inches, and rich luxuriant vegetation is limited to those belts which have a much higher rainfall. The mean temperature of India is from 75° to 85°, while that of Central Europe is from 45° to 60°, and under a higher temperature a larger amount of moisture is required to produce rich vegetation.

The supply of moisture in India is unequally divided over the seasons of the year; and in most parts there is a long dry and a short rainy season. The principal rains, over by far the larger part of the country, are due to the prevalence during the summer of the south-west monsoon. The most humid regions are those mountainous tracts which are fully exposed to the influence of the moist south-westerly winds. There are two zones with sufficient moisture for chinchona cultivation. One extends along the slopes of the Himálayas from the Sutlej to the eastern extremity of India, and then southward to Rangoon. It has a normal rainfall of 75 inches; but the eastern portion has a much heavier fall than the north-west; and at

Cherra on the Khasi hills there is the extraordinary fall of 600 inches. This zone, except the portion in Burma, is beyond the tropics. The other moist zone extends along the western coast of the peninsula, its eastern limit nearly coinciding with the crests of the ghâts, and its width varying from 50 to 100 miles. Bombay has a fall of 72 inches, Tanna 102, and it increases further south. At Ratnagiri it is 115, at Vingorla, 118, at Cananor, 123 on the coast; but the heaviest fall is on the crests of the ghâts. Here the moist currents of air, coming from the sea, strike against the steep faces of the mountains, are forced upwards into a cooler and more rarefied air, and cause an extremely heavy downpour during the monsoon. The fall is heaviest in the mountains above Bombay, and decreases to the south until, at Cape Comorin, the dry belt begins, with a fall under 30 inches. At Mahabaleswar the fall is 250 inches, while at a distance of ten miles inland from the crest of the ghâts, it is only 50 inches.

Of the two moist belts of India, the Himálayan region is not so suitable as that of the western ghâts, because it is beyond the tropics, and the climate is consequently not so analogous to that of the chinchona forests. I was, therefore, led to the selection of the western ghâts. But the northern part of them seemed to have too heavy a fall during the summer, and too dry a climate during the rest of the year, while the extreme south was too dry. The central portion of the ghâts, which is the same distance from the equator as

the most important chinchona region, and has a similar rainfall, with sites at suitable elevations above the sea, was, therefore, the best position for our great experiment; whence the cultivation, when once fully established, might radiate over less favourable regions.

This survey of the climates of India led me to the selection of the Nilgiri Hills for the establishment of our first plantations; and most fortunately the ablest arboriculturist in India, Mr. McIvor, had actually been in charge of Government gardens since 1848, on this very site. To his care I gladly, and with perfect confidence, handed over the difficult and critical task of converting the Peruvian bark trees from wild into cultivated plants.

We landed at the port of Calicut, on our way to the Nilgiri Hills, on the 7th October, 1860. He who would desire to receive the most pleasant impression of India, on a first arrival, must follow in the wake of Vasco da Gama, and disembark on the coast of Malabar, the garden of the peninsula. Here Nature is clad in her brightest and most inviting robes, the scenery is magnificent, the fields and gardens speak of plenty, and the dwellings of the people are substantial and comfortable.

Late in the evening, we embarked in a canoe on the Beypur river. The banks are wooded down to the water's edge, with groves of slender betel palms rising above the other foliage, and standing out against the starry sky. We were met by Mr. McIvor at the landing-place of Eddiwana, and started at once for the

village of Wundur, whence the road leads up the Sisapara ghât to the Nilgiris. The ascent commences at Sholakul, a post-house surrounded by stout palisades, to protect it from wild elephants. Thence the road first passes through a tract overgrown with gigantic weeds, and then up a steep slope, covered with a forest of black wood and other fine timber trees, with an undergrowth of ferns, *Curcumas*, and a brilliant little purple flower (*Torenia Asiatica*). The occasional openings in the forest, at turns in the road, afforded us views of the mountains below us, covered with the richest vegetation, and of the rice-fields of Malabar, stretching away to the faintly indicated blending of sea and haze on the far horizon. As we continued the ascent the scenery increased in magnificence, the views became more extensive, and there were mountain-tops crowned with grand forest trees far below us. At 6000 feet mosses appear, then lilies, brambles, and wild strawberries, and occasionally we crossed noisy little streams overshadowed by the trees. We reached the Sisapara bungalow, on the summit of the ghât 6742 feet above the level of the sea, late in the afternoon.

The Sisapara ghât takes the traveller from the tropical plains to the temperate climate of the hills, where the face of Nature is entirely changed. Here the slopes are covered with grass, and the ravines only are filled with trees, forming thickets called *sholas*. In the rear of the Sisapara bungalow, there is an almost unrivalled view of the Malabar plains, from the edge of a precipice. The Kundah hills sweep

round until they join the Wainad range, and appeared to be so steep that even a cat could not scale them for many miles; and far below were the forests, with occasional open glades. The distance from Sisapara to Utakamand, the chief English station on the Nilgiris, is thirty-three miles, fifteen of which are over the Kundah hills, and the rest of the distance is within the Nilgiris proper. As we rode round the artificial lake, and passed several pretty little houses surrounded by shrubberies, it was difficult to persuade ourselves that we were not in England. The garden in front of our hotel was stocked with mignonette, wallflowers, and fuchsias, but the immense bushes of heliotrope, covered with flowers, could not have attained such dimensions in an English climate. Utakamand is nearly in the centre of the table-land of the Nilgiris, at the foot of the western face of the peak of Dodabetta. Houses are scattered about under the shelter of the hills, with gardens and plantations of *Eucalyptus* and *Acacia heterophylla;* and the wide excellent roads are bordered by bushes of *Cassia glauca* with a bright orange flower, honeysuckles, foxgloves, geraniums, roses, and masses of tall *Lobelia excelsa.* A graceful white iris is also common.

This charming spot, with the roadsides planted with tall trees, and the hedges filled with all the familiar flowers introduced from Old England, while curling smoke ascends through the foliage, suggesting the idea of chimneys and warm firesides, is as unlike India as can be imagined. I felt sanguine that the species of

chinchona requiring lofty sites would thrive on the heights of Dodabetta, while suitable positions for those species which can bear a warmer climate would be found on the forest slopes which overlook the plains. A closer inspection confirmed me in this opinion.

CHAPTER II.

THE NILGIRI HILLS.

THE Nilgiri * hills, between latitude 11° 10′ and 11° 32′ N., and longitude 76° 59′ and 77° 31′ E., are, with the Animallés, the most elevated mountain masses in India, south of the Himálayas; the highest peak, that of Dodabetta, being 8642 feet above the level of the sea.† The Nilgiris are isolated on three sides. They rise up abruptly from the plains of Coimbator on the south, and from the table-lands of Wainad and Mysor on the north and east, to a height of 6000 feet above the former, and 2000 to 3000 above the latter; from which they are divided by the broad ravine of the river Moyar. On the west they are united with the Kundah range, which is a continuation of the western ghâts. The area of the Nilgiris contains 268,494 acres, of which upwards of 24,000 were under cultivation at the time of my visit in 1861.

* *Nil*, blue, and *giri*, a mountain; from the blue *Justitias* which cover many of the hill-slopes.

† In 1872 Major Branfill, of the Great Trigonometrical Survey, ascertained that the Aneimudi Peak, in the Animallé Range (south of the Nilgiris), is 8837 feet above the sea, and is, therefore, the loftiest height in India, south of the Himálayas. Until then Dodabetta was believed to be the highest. The height of Dodabetta was fixed by Colonel Saxton.

The formation consists of syenitic granite, with veins of basaltic rock, hornblende, and quartz, while, in some parts, half-decomposed laterite underlies the soil. The plateau is not a flat table-land, but a succession of undulating hills and intervening grassy valleys, with ravines thickly wooded, numerous streams, and occasional rocky ridges running up into fine mountain peaks. The streams all go to swell the great river Kaveri, by its tributaries the Moyar and Bhawani; the Moyar descending from the hills by a fine waterfall at Paikâra on the northern slope, and the Bhawani flowing down between the Kundahs and Nilgiris to the south. The soil of the plateau is very rich, being formed by the decomposition of basaltic and hornblende rocks, mixed with the clayey products of the granite, and much decomposed vegetable matter. The latter consists of the grass killed down to the roots by the frost, washed in by the succeeding rains, and mixed with the subsoil, increasing in richness and depth season after season. The richest land is on the lower slopes, where there are accumulations of soil washed from the hills above:* and there are extensive deposits of peat in the valleys, which afford supplies of fuel. The chief defect in the soil is the absence of lime.

The temperature and amount of humidity vary according to the locality. At Utakamand, 7416 feet above the sea, the means of the thermometer range

* Report of Captain J. Ouchterlony, Superintendent of the Nilgiri Survey in 1848.

from 42° to 68°, while in the two other lower and warmer stations of Kunur and Kotagiri, about 6000 feet above the sea, the range is from 52° to 71°. The annual rainfall at Utakamand is sixty inches, at Kunur fifty-five inches, and at Kotagiri fifty inches. During the south-west monsoon, from May to September, the rain comes down in torrents at Sisapara, and in the western parts of the Nilgiris, but their force is somewhat exhausted before reaching Utakamand, in the centre of the plateau. At that station the rainfall, during the south-west monsoon, is about thirty-four inches; and the range of Dodabetta, which rises up like a wall, immediately to the eastward of Utakamand, almost entirely screens the eastern part of the hills from the rains of the south-west monsoon, and there the rainfall is only twelve inches from May to September. During the portion of the year from October to April, the western parts of the hills are comparatively dry, the prevalent winds are from the north-east, and the rains which they bring with them from the Madras coast do not extend farther west than the neighbourhood of Utakamand. Kotagiri, and the eastern parts of the hills, receive the full benefit of the rains from the north-east monsoon, but they are not heavy, and the rainfall at Kotagiri, in that season, is thirty-eight inches. Utakamand also gets some of the rain of the north-east monsoon (thirty-six inches), so that, in that central part of the plateau, there is a belt which receives a moderate supply of rain throughout the year. In January and December there are

frosts in the night, and the extreme radiation which goes on in the valleys causes great cold at sunrise; but these frosts are confined to the valleys in the upper plateau, and they never visit the higher slopes, or the well-wooded "*sholas.*"

The climates of the Nilgiri hills are the most delightful in the world; and it may be said of this salubrious region, with its equable seasons, what the Persian poet said of Kung, "the warmth is not heat, and the coolness is not cold."* On the open plateau, in the wooded *sholas*, and in the thick forests of the lower slopes, there is a great variety of beautiful flowering trees and shrubs; and the vegetation of the hills is both varied and luxuriant. First, in the brilliant splendour of its flowers, must be mentioned the tree rhododendron (*Rhododendron arboreum*), which is very common in all parts of the hills, either forming small thickets or dotted about on the grassy slopes. It grows to a height of twenty feet, with a gnarled stunted trunk, and masses of deep crimson flowers. In the *sholas* are the *Michelia nilagiraca*, a large tree, with yellowish white flowers of great size; the *Symplocos pulchra*, with hairy leaves and snow-white flowers; the *Ilex Wightiana*, a large umbrageous tree, with small white flowers and red berries; the pretty pink-flowered *Rhodo-myrtus tomentosa*, the berries of which are called "hill-gooseberries;" the *Jasminum revolutum*, a shrub with sweet yellow flowers; the *Sapota elingoides*, a fine forest tree, with rough cracked bark, and an edible fruit used in

* Ferdesi.

curries; *Crotalariæ; Bignoniæ;* peppers, cinnamon, a number of chinchonaceous shrubs, and many others.

In the open grassy slopes and near the edges of the wooded ravines are several *Vaccinia*, especially the *Vaccinium Leschenaultii*, a shrub with pretty rose-coloured flowers; the beautiful *Osbeckia Gardneriana*, with a profusion of large purple flowers; the handsome *Viburnum Wightianum;* a number of balsams (*Impatiens* of several species); the *Gaultheria Leschenaultii* in great quantities, a pretty little shrub with white flowers and blue berries; the *Berberis Mahonia*, with its glossy prickly leaves and long slender racemes of yellow flowers; and the bright little pink *Indigofera pulchella;* while the climbing passion-flower (*Passiflora Leschenaultii*) hangs in festoons over the trees, especially in the eastern parts of the hills. Among the more inconspicuous plants are the *Gallium requienianum;* the *Rubia cordifolia;** the thorny *Solanum ferox*, with stem and leaves covered with strong straight prickles; the *Girardinia Leschenaultii*,† or Nilgiri nettle, a most virulent stinger; the tall *Lobelia excelsa;* a *Justitia*, with a blue flower, which entirely covers some of the hills; some pretty *Sonerilas;* several beautiful *Ipomœas*

* Dr. Wight says that this plant might be collected in vast quantities with little trouble or expense, and yields an excellent red dye.

† This nettle is frequent all over the higher ranges of the Nilgiris. The bark yields a fine strong fibre, which the natives obtain by first boiling the whole plant, to deprive it of its virulently-stinging properties, and then peeling the stalks. The textile material thus obtained is of great delicacy and strength.—Wight's *Spicelegium Nilgirense.* The fibre of the Nilgiri nettle is worth £200 a ton in England, and its cultivation is likely to be a remunerative speculation.

and *lilies; Celsias;* and the *Hypericum Hookerianum,* growing plentifully in the meadows, with large orange flowers; besides ferns, lycopods, and numberless small wild flowers in the grass and underwood. Since 1848 gum-trees and acacias have been introduced from Australia. The Eucalypti form large plantations for firewood, and they grow in rows and clumps round the stations, forming a special feature in the landscapes.

Enjoying a delightful climate, well supplied with water, and with its gentle undulations of hill and dale in some places clothed with rich pasture, in others presenting woods of fine timber and beautiful flowering shrubs, the Nilgiri hills are eminently fitted for the abode of a thriving and civilised people. Yet for many centuries it would appear that their sole inhabitants were a strange race of cowherds, called Todas.

In 1820 Mr. John Sullivan, the Collector of Coimbator, built the first house in Utakamand, on the site of a Toda mand or village of the same name.* It was afterwards used as the building for the Lawrence Asylum. The first sanatarium on the hills, however, was at Dimhati, on the eastern side, and at the adjoining station of Kotagiri, but the former is now abandoned. The delightful climate soon attracted crowds of visitors from the burning plains; many houses gradually rose up on the grassy slopes round the lake which was formed at Utakamand by bunding up one end of the valley, and the place rapidly became an important hill-station. A small native town and bazar sprang up on

* Literally, "one stone village."

the banks of the lake, a handsome church was erected, a club-house, and, most conspicuous of all, an immense Parsí shop kept by Framjí Nasarwanjí of Bombay. The roads are excellent, and planted with tall graceful acacia and gum trees from Australia, and many of the houses are surrounded by beautiful gardens and shrubberies. The most charming, perhaps, is that of the late Bishop Dealtry, called Bishops-down, whence there is a glorious view of the station on one side, and of the distant Kundah hills, overtopped by the sharp peak of Makurti, on the other. Advantage has here been taken of a wooded *shola* to make pleasant shady walks, and to cut vistas through the trees.

The warmer station of Kunur is about nine miles from Utakamand, at the head of the ghât which leads down to the plains of Coimbator. Here the scenery is far more beautiful than at the central station, as the wooded sides of the ghât run up into a fine peak called the Hulikul drug, and the view extends far away over the plains. The houses are perched on the rounded tops of a range of hills, and there is a church with a fine tower, which is a great addition to the view of Kunur from the surrounding eminences. A mile from Kunur, in the direction of Utakamand, is the military station of Jakatala. It is well sheltered by high hills from the cold north winds to which Utakamand is exposed, as well as from the south-west monsoon, and is in every respect admirably adapted as a sanatarium for soldiers and their families.

The English settler on the Nilgiris will find English

fruits, flowers, vegetables, and grasses, the introduction of which is mainly due to the exertions of Mr. William G. McIvor, the Superintendent of the Government gardens at Utakamand, and for many years also Superintendent of Chinchona plantations in Southern India. He was in charge of the gardens at Utakamand from 1848 until his death in 1876, uniting zeal, intelligence, and skill to the talent and experience of an excellent practical gardener. Under his auspices the steep slopes of one of the spurs, which run off from the peak of Dodabetta and overlook the cantonment of Utakamand, were converted into a tastefully laid-out garden, in a succession of terraces. With no assistance beyond that of an East Indian foreman and labourers from the Mysor plains, Mr. McIvor succeeded in changing the wild mountain-sides into a very beautiful public garden. Every point of view was taken advantage of with admirable taste, and numerous trees and flowering shrubs were introduced from England, Australia, and other countries, while the native flora of the hills was fully represented. There were English roses and geraniums, ponds bordered by white arums, shady walks overarched by trellis-work, tasteful vases filled with showy flowers, thickets of rhododendrons, hedges of heliotrope and fuchsia, fine clumps of tall spreading trees, and from the upper terraces, between the leafy branches, there are glorious views of the Utakamand valley, and of the finely broken range of the distant Kundah hills.

Mr. McIvor also had a small branch garden at

Kalhati, about halfway down the Sígur ghât, leading to the Mysor plains, for raising fruits which require a warmer climate. This garden was self-supporting. A magnificent waterfall descends into a rocky basin close beside it, and the garden contained oranges of many kinds, shaddocks, lemons, limes, citrons, nutmegs, loquats, and plantains.

CHAPTER III.

CHINCHONA SITES ON THE NILGIRI HILLS.
THE DODABETTA SITE—THE NEDIVATTAM SITE.

In selecting sites for chinchona plantations on the Nilgiri hills, I had to compare the climate and other conditions of growth which prevail in the chinchona forests and open *pajonales* in the Andes with any similar localities which might be found in Southern India. For the first experimental sites, it was important that the resemblance, as regards elevation, temperature, and humidity, should be as close as possible; but there was every reason to hope that, under cultivation, these plants, like most others, would adapt themselves to conditions of soil and climate extending over a more extensive area.

It was necessary to fix upon two sites in the first instance: one at the highest point at which chinchona plants were likely to flourish, for the species from Loxa and others growing at great elevations; and another, in a lower and warmer position, for the plants of *C. succirubra*, *C. Peruviana*, *C. micrantha*, and the *C. Calisaya*. The highest point at which these plants will flourish, and the greatest exposure they will bear

without injury, are, as a rule, the most favourable conditions for the formation of the alkaloids; while, if the *sholas* in the upper plateau of the Nilgiri hills proved to be adapted for their growth, their cultivation might be indefinitely extended in a climate suitable for English settlers.

Previous to my arrival on the hills, Mr. McIvor had selected a site for the highest plantation in a wooded ravine or *shola* at the back of the hills which rise above the Government gardens; and, after a careful examination, I came to the conclusion that it was well suited for the growth of the hardier species, and for the experimental culture of all the kinds which have been introduced into India. It has been named the "Dodabetta" site, from the peak of that name, the highest point of the Nilgiris, and 8642 feet above the sea, which rises up immediately behind it.

With regard to the species for which I considered the Dodabetta site to be suitable, it will be well in this place to recapitulate the circumstances under which they grow on their native mountains.

The shrub variety of *C. Calisaya* (lat. 13° to 15° S.) flourishes in open *pajonales*, quite exposed, at elevations from 5000 to 7000 feet above the sea, and in April and May I found the mean temperature to be $60\frac{1}{2}°$, minimum 55°, and range 17°. The *C. nitida* (lat. 10° S.) grows at similar elevations, but we have no exact information respecting the temperature and humidity. The varieties of *C. officinalis* (lat. 4° S.) flourish at heights from 6000 to 8000 feet above the sea, where the mean range is from

45° to 60°, in a moist climate, and in exposed but always dry situations; and one kind, the *C. crispa*, grows in a deposit of peat, 8000 feet above the sea, in a temperature falling as low as 27°. The *C. lancifolia* (lat. 5° N.) is found at 7000 feet above the sea and upwards, where the annual range is from freezing-point to 75°, in an exceedingly moist climate. The rainy season lasts for nine months, when the constant rain is only interrupted in the day by interchanging sun-rays and fog-clouds. In the dry season, cold clear nights follow days in which a warm sun penetrates through the fog, which almost constantly lies on the damp foliage of the forest.* Mr. Cross mentions that he saw trees of *C. succirubra* on his way to Loxa, growing at elevations of from 8000 to 9000 feet above the sea.

The site, in the Dodabetta ravine, slopes down from 8000 to 7500 feet above the sea, yet, from local causes, it is several degrees warmer than the station at Utakamand; and the temperature agrees with that of the species of chinchona plants described above.

The Dodabetta site, being four or five degrees warmer than Utakamand, throughout the year has a temperature, on the whole, somewhat warmer than the lofty regions where the species of chinchona grow, for the cultivation of which this position was selected. The mean temperature in the shade is 60°, and the maximum 70°. The elevation above the sea exactly corresponds, and the amount of humidity is about the same. The ravine is full of fine trees, with a variety of

* Karsten.

exposures, the general aspect being north-west; a clear little stream flows through it; and, in most parts, the soil consists of a rich surface mould two feet deep. The substratum is gneiss, with decomposed felspar and hornblende. Outside the wooded ravine there are tree Rhododendrons, Berberis, Gaultherias, Lilies, Lycopodia, and brake-ferns, scattered about on the grassy slopes; and the character of the scenery and vegetation very closely resembles that of the *pajonal* country between the valleys of Sandia and Tambopata in Caravaya, where the shrub *Calisaya* flourishes. The site is protected by rising grounds from the northerly winds, and the colder breezes blowing over it from ridge to ridge prevent the warm air in the ravine from rising, so that the temperature became warmer as we ascended through the wood, and in the highest part there were orchids and pepper-vines hanging on the trees.

The analogy between the flora of the Dodabetta ravine and of the loftier parts of the chinchona region was another point which influenced my decision. Within the ravine there are nine species of chinchonaceous plants, namely—

Hedyotis Lawsoniæ.
Hedyotis stylosa.
Lasianthus venulosus.
Coffea alpestris.
Coffea grumelioides.
Canthium umbellatum.
Grumilea elongata.
Grumilea congesta.
Psychotria bisulcata.

These are mostly ornamental pretty shrubs, from six to eight feet high, with clusters of white or cream-coloured flowers. The other genera of which the wood is composed are as follows:—*Vaccinium, Myrsine, Symplocos, Ilex, Michelia, Sapota, Isonandra,* and *Cinnamon,*

among the trees; *Eugenia, Myrtus, Jasminum, Osbeckia, Sonerila, Solanum, Viburnum,* and *Acanthus,* among shrubs; *Lonicera, Passiflora, Rubia,* and *pepper-vines,* among the climbers; with an undergrowth of *Lobelia, Begonia, Convolvulus,* orchids and ferns. The *Osbeckias* and *Sonerilas* represent the melastomaceous plants, the constant companions of chinchonæ in South America.

It was no small advantage that this excellent site for a chinchona plantation was close to the Government gardens, and that it was thus under the constant supervision of Mr. McIvor. It receives a supply of moisture during both monsoons, and is therefore as good a position as could have been selected on the higher plateau of the Nilgiris, though there are many *sholas* which are equally well adapted for the growth of the hardier chinchonas.

The most extensive operations are, however, necessarily carried on at much lower elevations, where the *C. succirubra,* the species richest in febrifuge alkaloids, flourishes best, and where vast unoccupied forests afford space for plantations on a large scale. A northern aspect is the one best adapted for the vigorous growth of trees on the Nilgiri hills, and we therefore proceeded to examine the forest-covered slopes overlooking the table-lands of Wainad and Mysor, for a site for the lower chinchona plantation. We started from Utakamand early one November morning, and rode across the central plateau of the hills, consisting of rounded grassy undulations, intersected by wooded *sholas.* In some of the hollows the streams had formed large swamps, where there were extensive deposits of peat.

The travellers' bungalow of Paikâra, the first on the road towards Wainad, is ten miles from Utakamand, on the banks of a river of the same name. Several huge boulders of syenite obstruct the stream and cause it to foam noisily round them, and the wet stones were covered with *Podostemads*, herbaceous branched floating plants, with the habit of liverworts. We saw several otters playing in the water, and peering at us from behind the rocks. Six miles beyond Paikâra is the bungalow of Nedivattam, on the edge of the rapid descent into Wainad, and the road passes from the upland slopes through a jungle where the ferns first appear, maidenhair, ceterach, and other species growing by the roadside. Some garden marigolds from England had been planted near the Nedivattam bungalow, and they had spread themselves in masses over the adjacent slopes.

The tract of forest land which we came to examine is close to the bungalow, and from the grassy hill above it there is a glorious view of Wainad, and of the plains of Mysor, stretching away to the horizon. It is eighteen miles from Utakamand. Here the mountains sink abruptly to the Wainad table-land, and the Moyar river thunders down in a long waterfall, divides Wainad from Mysor, and, flowing through a deep gorge to join the Bhawani in Coimbator, eventually swells the waters of the great river Kaveri. The land available for immediate occupation comprised about 400 acres of uncleared forest on the mountain slopes, at an elevation from a little over 6000 to a little under 5000 feet above the level of the sea, and with a mean temperature about 8° warmer than that of Utakamand.

I selected this site for a plantation of *C. succirubra, C. Calisaya, C. micrantha,* and the very delicate *C. Peruviana,* because, with a good supply of water, and a deep rich soil on a base of decomposing laterite and syenite, it had a good slope, a suitable elevation above the sea, temperature, and amount of humidity. The information we possess on these points, with regard to the above species, was by no means complete; but it was sufficiently exact to enable us to form a correct opinion. Dr. Spruce gives the following details respecting the climate of the region of *C. succirubra,* in latitude 1° 40′ S. The zone of the "red bark" is from 2450 to 5000 feet above the sea.

1860. — Month.	Mean Min. for 7 Months.	Mean Max. for 7 Months.	Mean of Minima & Maxima.	Lowest Temperature.	Highest Temperature.	Range in 24 hours. — Entire range in 7 months.
	°	°	°	°	°	°
	61½	72⅕	66¾	57	80½	23½
	°	°	°	°	°	°
June .	6 ⅕	74	67½	60½ on the 27th.	77 on the 29th.	12⅘
July .	60	72½	66¼	57 on the 11th.	80½ on the 27th.	12½
Aug. .	61⅓	74⅔	68	59¾ on the 12th.	80¼ on the 28th.	13⅓
Sept. .	62¼	72½	67½	60 on the 16th.	80 on the 19th.	10¼
Oct. .	62	70	66	60 on the 21st.	74 on the 24th.	8
Nov. .	62⅕	71	66½	58 on the 29th.	75 on the 30th.	8⅘
Dec. .	62	71½	66¾	..	..	9½

From the 1st of June to the 31st of December is the dry season in the "red bark" region, when the days are usually sunny in the early morning, and mists begin to form as the sun declines; while after the autumnal equinox there are heavy rains and thunder-storms. In the wet season the early part of the day is foggy, and there is heavy continuous rain during the afternoons and nights. In the region of *C. Calisaya*, from 13° to 16° S. lat., and from 4000 to 6000 feet above the sea, the dry season lasts from April to the end of August. April and August are showery months. May is also showery, but clear in the forenoons, and the mean temperature during the first half is 69°, mean maximum 71½°, and mean minimum 62½°. June and July are hot dry months, with little rain, a bright hot sun in the day, but cold clear nights. In September the rains begin, increase in October, and pour down incessantly from the beginning of November to the middle of March, with very hot, damp days and nights. We have no detailed information respecting the region of *C. micrantha* and *C. Peruviana*, species which flourish in 10° S. lat., from 4000 to 5500 feet above the sea. From May to November the sun shines powerfully, yet heavy rains fell from day to day in June and July 1860, and it was not until August that the days were clear and bright. At Casapi, in this region, where a register was kept, it rained during half the days in the year.* From November to May is the rainy season, and sometimes

* Smyth's *Journey from Lima to Para*, p. 115.

the rain pours down for six or seven days without intermission.*

The Nedivattam site, being about 8° or 10° warmer than Utakamand, has a temperature exactly similar to that of the forests where the above species of chinchonæ flourish. The mean temperature in the shade is 60°, maximum 80°, and minimum 54°. The average rainfall is 105 inches, but all falling in 125 days. From November to May the sky is clear and the sun powerful; and this long drought might, I feared, be prejudicial to some species. From May to November there are clouds and rain. The elevation above the sea is the same as that of the chinchona forests. It is true that Dr. Spruce gives the extreme upper limit of the "red bark" region at 5000 feet; but Mr. Cross saw that species growing at an elevation of 8000 feet; and the great importance of cultivating this species at the highest possible elevation was demonstrated by Dr. Spruce's observation that the bark of trees growing low down and near the plains is by no means so thick as that of trees which flourish in a loftier and more temperate climate.† The Nedivattam site is within the limit of the region which receives both monsoons. Though protected to some extent from the south-west, it has its full share of the rains during the summer, and also receives occasional moisture from the north-east monsoon, coming across Mysor between October and December. During the remaining months it is

* Dr. A. Smith's *Peru as It Is*, ii. p. 57.

† Dr. Spruce's *Report*, p. 27.

visited by dews in the nights until the south-west monsoon again commences in May. It has been found that these species of chinchonæ will bear a much drier climate than we then supposed; but I had no misgivings that the amount of humidity at Nedivattam would not be sufficient for their successful cultivation. The only other person who visited this site after its selection, and was capable, through personal knowledge of the South American chinchona forests, of forming an opinion, was Mr. Cross. It was exceedingly satisfactory to find that he not only approved of it for the cultivation of plants of the "red bark" species, but that, from the superior depth and richness of the soil, he considered that they were likely to thrive even better than in their native forests near Limon, on the eastern slopes of Chimborazo.

In the Nedivattam forest, among other plants, I found the *Hymenodictyon excelsum*,* wild yams, coffee-plants, cinnamon, pepper-vines, *Andromedas*, *Osbeckias*, wild ginger, a *Balanophra* with a scarlet flower, and abundance of orchids and ferns. On the edge of the forest there was a little hut, merely a few branches covered with grass, and leaning against the trunk of a tree, with some empty honey-combs lying about. It was the habitation of a family of Mulu Kurumbas, a wild people who live in the forests, and run away in great terror when any one approaches them.

The magnificent view from this point embraces a

* Called *Chinchona excelsa* by Dr. Roxburgh, but excluded from the list of Chinchonæ by Dr. Wallich, who gave the plant its present name.

great part of Wainad. Far below there was a small coffee estate, its bright green contrasting with the more sombre hues of the surrounding forest; and more to the left, though out of sight, is the extensive plantation which, together with a tract of forest on the slopes of the Nilgiris, was owned by Messrs. Ouchterlony and Campbell.

After passing the night at Paikâra, we started next morning to examine another site farther to the eastward, and overlooking the plateau of Mysor. We crossed several ranges of grassy hills, with streams in the intervening valleys flowing through thickets of tree rhododendrons, with the georgeous crimson flowers just beginning to bloom, *Osbeckias*, and á *Lasianthus* with a beautiful glossy leaf. The hills were dotted with a St. John's-wort with a bright orange flower (*Hypericum Hookerianum*). We soon reached the edge of the plateau, overlooking the low country, and looked down on the wide plains of Mysor, with some Nilgiri peaks in advance of us, and a valley between, where there was bright green cultivation, and crimson patches of amaranth, surrounding the Badaga village of Cholur. Between the place where we stood and the Cholur valley there were some fine patches of forest on the steep hill-slopes; but they did not offer the same advantages as Nedivattam for a first experimental chinchona plantation. This side of the hills is drier, the soil poorer, and water is less abundant, though it is nearer Utakamand, and both labour and supplies are more easily procurable. In returning to Utakamand we

rode up to a Toda mand, where something unusual had evidently occurred. About thirty Todas were walking in a line through the forest glades below, and several jackals were prowling about in the broad daylight. We afterwards heard that a huge tiger had killed one of the Toda buffaloes that morning, and retreated into the *shola* on the edge of which we had just had luncheon. They expected him to come out at sunset for his supper.

We continued our excursion to the summit of the Kalhati peak, overlooking the Sígur ghât, whence several fine tracts of forest land slope down; but Nedivattam was decidedly preferable in every respect to all the localities which we examined on the northern side of the Nilgiris, and to the eastward of that site. The part of the hills on the south, towards Kunur and Kotagiri, was out of the question on account of the summer drought, as it is completely screened from the south-west monsoon by the spurs from the Dodabetta peak; and the forests towards the Sisapara ghât, being too far west to receive moisture from the north-east monsoon, were not so good as Nedivattam for a first experiment.

As soon as the success of the chinchona culture on the Nedivattam plantation was fully established, the experiment was extended to the east and west, both by Government and through private enterprise; and these precious barks now yield remunerative profits to European speculators, while they at the same time confer an inestimable blessing on the native population.

CHAPTER IV.

CHINCHONA CULTIVATION ON THE NILGIRI HILLS.

IT is necessary, in order to make the history of the progress of chinchona cultivation quite clear, to preface an account of the work on the plantations, by referring to the administrative and scientific aid which supported and guided that work. While superintending, during a series of years, the completion of the enterprise in South America, I also had administrative charge of all the work at the India Office relating to the chinchona undertaking, and was thus enabled to watch and assist the cultivation in India, to be in constant communication with Mr. McIvor, and to give him support and help on the frequent occasions when they were needed. In this place, also, I will refer generally to the invaluable scientific counsel that was received from Mr. J. E. Howard and Dr. De Vrij, and to the cordial co-operation of the distinguished Director of the Royal Botanical Gardens at Kew.

I was in charge of the conduct of the enterprise and of all business connected with it at the India Office until the end of 1877, and always worked in cordial co-operation with Mr. McIvor until his death. I also enjoyed the advantage of receiving assistance and

advice from Mr. Howard, the accomplished quinologist and manufacturer of quinine, whose knowledge of the chinchona genus is unrivalled; from the late Mr Daniel Hanbury, and from Dr. De Vrij the eminent Dutch chemist; while unfailing aid was always cordially extended to the great work by Sir William Hooker and Sir Joseph Hooker. The Royal Botanical Gardens at Kew, where the plants have been received on their arrivals from Panama, and whence they have been despatched to India, have, through the kindness and ever-ready help of their Director, formed an important feature in the steps towards final success.

One of my chief cares was to keep the cultivators fully supplied with information on the subject of their charge. With this object I printed translated editions, in pamphlet form, of several reports and papers on the subject of Peruvian bark trees. These English editions consisted of the Reports of Junghuhn, De Vrij, and Van Gorkum on the plantations in Java;* of the

* *The Cultivation of the Quina tree in Java to the end of* 1859, described by Franz Junghuhn and J. E. De Vrij. Translated from the *Bonplandia*, July and August, 1860. (Spottiswoode, 1861.)

Yearly Reports for 1860 *and* 1861 *respecting the condition of Quinine Cultivation in Java*, by Dr. F. Junghuhn. Translated from the Dutch. (Spottiswoode, 1864.)

Statement by Dr. Franz Junghuhn, translated from the Dutch, with some explanatory notes, by Clements R. Markham. (Spottiswoode, 1863.)

Preliminary Guide to the Cultivation of Quinine, by Dr. F. W. Junghuhn, and notes in connection therewith. Translated from the Dutch. (Spottiswoode, 1864.)

On the Chinchona Bark of British India, by Dr. J. E. de Vrij. (Reprinted from the *Pharmaceutical Journal* of June 1864.)

On the Cultivation of Quinine in Java and British India, by Dr. J. E. de Vrij. Translated from the Dutch. (Spottiswoode, 1869.)

[*Chinchona*

important work on Peruvian barks by M. Gustave Planchon, of Dr. Weddell's "Notes on the Quinquinas," of Poeppig's account of the bark trees of Huanuco, of the botanical section of the work of Mutis, and of the descriptions of chinchona and their habitat by Dr. Karsten.* I paid two visits to Madrid to examine the Herbaria at the Botanical Gardens, and during the second visit I obtained a copy of the inedited manuscript of Mutis, which I printed for the first time.† The coloured drawings were afterwards reproduced by Dr. Don José Triana, for whose publication I obtained a grant from the Secretary of State for India.‡

I also arranged that all the correspondence relating

Chinchona Cultivation in Java. An abstract of M. Van Gorkum's Report for 1864. Translated from the German. (Spottiswoode, 1867.)

* *Peruvian Barks*, by Gustave Planchon. Translated from the French. (Spottiswoode, 1866.)

Notes on the Quinquinas, by H. A. Weddell. Translated from the *Annales des Sciences Naturelles*, 5th series, vols. xi. and xii. (Spottiswoode, 1871.)

Notes on the Chinchona trees of Huanuco, in Northern Peru, by Edouard Poeppig. From pages 217 to 223, and 237 to 264 of vol. ii., of his *Reise in Peru während der Jahre* 1827–32. Translated from the German.

The Chinchona Species of New Granada, containing the botanical descriptions of the species examined by Dr. Mutis and Dr. Karsten, with some account of those botanists and of the results of their labours, by Clements R. Markham. (Spottiswoode, 1867.)

† *Report on the specimens of Chinchona in the Herbaria at Madrid*, by Clements R. Markham. (Spottiswoode, 1866.)

‡ *Nouvelles études sur les Quinquinas, accompagnées de fac-simile des dessins de la Quinologie de Mutis, suivies de remarques sur la culture des quinquinas, par J. Triana. Ouvrage honoré des encouragements du Gouvernement de S. M. Britannique.* Folio. Coloured plates. (Paris, 1870.)

to the chinchona enterprise should be printed, through being asked for in Parliament. At my request this was done by Mr. Wm. Ewart in 1863 and 1866, and by my old messmate, the Hon. Fred. Walpole, in 1870. I was thus able to arrange for publication and to pass through the press, all the Reports and other documents relating to the chinchona enterprise from 1852 to 1870 inclusive. I prepared and added several maps to illustrate the Reports. The correspondence from 1870 to 1875 has since been asked for by Mr. Muntz, and was presented in 1876 and 1877. The whole is included in five Parliamentary Blue Books, which have been extremely useful to inquirers in this country and to cultivators in India.*

The magnificent work of Mr. Howard, based upon the "Nueva Quinologia" of Pavon,† was also of material assistance to cultivators in India, and several copies were sent out for distribution. But the greatest debt of gratitude is due to Mr. Howard for undertaking the laborious analysis of barks from the Nilgiri plantations, and for furnishing those Reports which

* Blue Book. I. East India (Chinchona) Correspondence, March 1862 to March 1863 (Printed 1863).
" II. East India (Chinchona) Correspondence, April 1863 to April 1866 (Printed 1866).
" III. East India (Chinchona) Correspondence, April 1866 to April 1870 (Printed 1870).
" IV. East India (Chinchona) Correspondence, August 1870 to July 1875 (Printed 1876).
" IV. and V. East India (Chinchona) Correspondence, August 1870 to July 1875 (Printed 1877).

† *Illustrations of the Nueva Quinologia of Pavon, with forty coloured plates, by W. Fitch, F.L.S.; and observations on the barks described by John Eliot Howard, F.L.S.* (Folio, 1862.) Lovell Reeve.

have been such invaluable guides to the cultivator.* Mr. Howard embodied the results of his investigations in a work entitled "Quinology of the East India Plantations," † which has also been of great service to the cultivators in India. Mr. Howard's aid has thus been, from the very first, of great value and importance. It has been highly appreciated, and on the 17th of October 1873 I had the pleasure of addressing to him the following letter:

"SIR,—I am directed by the Secretary of State for India in Council, to convey to you his best thanks for the valuable assistance you have frequently given, both by advice and by performing laborious and difficult analyses, in the promotion of chinchona cultivation in British India. The important and costly works you have published on the chinchona genus have been of essential use, both to those who collected plants and seeds of various species in South America and to the cultivators in India. Your analyses, and the valuable remarks with which they are illustrated, have furnished excellent guides to those who are in charge of the plantations; and the numerous occasions, during a

* Reports on analysis of East India Bark, by J. E. Howard, Esq.

1st.	28 May, 1863.	(*Chinchona Blue Book* of 1866,	p. 14.)
2nd.	15 June, 1864.	(„ „	„ p. 48.)
3rd.	1 Aug. 1865.	(„ „	„ p. 134.)
4th.	4 Feb. 1867.	(„ „	1870, p. 34.)
5th.	28 Aug. 1867.	(„ „	„ p. 134.)

† *The Quinology of East Indian Plantations*, by John Eliot Howard, F.R.S. (Folio. Lovell Reeve, 1869.)

The Quinology of East Indian Plantations, by John Eliot Howard, F.R.S., Parts II. and III. Coloured plates. (Folio. Lovell Reeve, 1876.)

course of years, on which you have given advice and assistance of various kinds, have furthered the progress of the undertaking very materially. His Grace * desires me to assure you that the services which you have so zealously and constantly rendered are fully appreciated, and that your aid is considered, by Her Majesty's Government, to have furthered in no small degree the success of this undertaking, which will hereafter be most beneficial to the people of India.

"I have, &c.,

"CLEMENTS R. MARKHAM."

The assistance and advice I have constantly received from Dr. J. E. de Vrij, the eminent Dutch quinologist, have also been of great importance. Formerly in chemical charge of the chinchona plantations in Java, Dr. De Vrij has also personally inspected our own Nilgiri plantations. He has always taken a warm and enthusiastic interest in the success of chinchona cultivation, and, above all, he has devoted his profound chemical knowledge and great abilities to the discovery of the form of febrifuge which combines, in the highest degree, the two requisities of efficacy and economy. More especially as regards his investigations with this end in view, Dr. De Vrij has done much to ensure the final success of this great undertaking.

But the most important work was intrusted to Mr. McIvor. He was called upon to undertake the difficult task of converting the chinchonæ from wild into

* The Duke of Argyll, then Secretary of State for India.

cultivated plants, an achievement which he performed with complete success. His zeal and ability, his knowledge of the climate and soils of the Nilgiri hills, and his acquirements as a practical gardener, pointed him out as the fitting man to receive this great charge. He had the advantage of personal intercourse, for weeks together, with Mr. Cross, Mr. Weir, and myself, after we had explored and carefully examined the conditions prevailing in the chinchona forests of South America; and he was thus able to form a correct judgment on the requirements of the plants under cultivation.

In July 1861 Mr. McIvor was appointed Superintendent of chinchona cultivation on the Nilgiri hills, with full and entire control over the operations, in direct communication with the Government, and subject to no interference from any intermediate authority. Orders to the same effect were sent out to Madras by the Secretary of State for India in Council on July 2nd, 1861, and the same orders were repeated both to the Governor-General and to the Governor of Madras, in despatches dated February 1862. It was above all things important that Mr. McIvor's position, in connection with the chinchona experiment, should be authoritatively defined, in order to protect him from attempts at interference by incompetent persons.

I will now proceed to give an account of the commencement of chinchona cultivation in the Nilgiri hills. The first batch of seeds, being those of the "grey bark" species from the Huanuco forests, arrived at Utakamand on the 13th of January 1861, and those of

the "red bark" followed in the end of February. On the 7th of April, 463 plants of *C. succirubra* reached their destination on the Nilgiri hills in very good condition, considering the length of time they had been in Wardian cases, and thus the experiment was fairly commenced.

The first sowing, which took place in January, was not very successful, because Mr. McIvor was induced to use too retentive a soil, and only 3 to 4 per cent. germinated. The second sowing took place early in March, the soil used being of a much freer nature, half composed of burnt earth; and 15 to 25 per cent. germinated. Encouraged by this result, Mr. McIvor used a soil composed entirely of burnt earth for the third sowing, which took place in the beginning of April, and included the seeds of the "red bark" species. Of this sowing 60 per cent. germinated, and of the seeds of *C. micrantha* 90 per cent. It is to be remembered that all these seeds were collected in the South American forests some months before, and that they had passed through the perils of several climates, and a voyage of many thousands of miles. In May all the plants of *C. succirubra* had taken fairly to the soil, and were in a healthy and flourishing condition. The temperature given to the plants was 60° in the morning, rising to 75° in the day, with plenty of light and air; this treatment having proved to be best adapted for their rapid growth.

During the autumn of 1861 the work of propagation, by means of cuttings and layers, progressed rapidly;

and whereas in June 1861 we only had 2114 chinchona plants of valuable species at Utakamand, in January the number was increased to 9732 plants. The layers of *C. succirubra* root sufficiently to be removed in five weeks, and cuttings in two months; layers of the "grey bark" taking a little longer time to root, or about six weeks. Mr. McIvor also made the important discovery that chinchonæ strike freely from *eyes*, and make beautiful plants exactly like strong seedlings. These *eyes* give about eight fine strong plants for one that is obtained from cuttings, which is a great advantage while there is not much wood in the young plants. In October Mr. McIvor reduced the temperature of one of the propagating-houses to 55° at night, and 65° during the day; and under this treatment, which is also probably advantageous to the bark, the plants appeared to grow faster, and the leaves became a very beautiful bright green. The experience of a year's cultivation convinced Mr. McIvor that, although the most suitable elevation and climate differ with the various species, yet that they all require a rich, rough, and very open soil. In September 1862 the erection of a new propagating-house for chinchona plants, in the Government gardens at Utakamand, was sanctioned, which was completed early in December.

The Dutch Government in Java, at the request of the Government of India, arranged to forward some chinchona plants of the species cultivated in that island; and accordingly 100 of *C. Calisaya*, and 7 of *C. lancifolia*, were transmitted. Of these 48 of *C. Calisaya*, and 4 of

C. lancifolia, arrived at Utakamand on the 20th of December 1861. In exchange for these plants a supply of *C. succirubra*, and a proportionate number of the other species, was sent to Java, "not more in return for the accession actually received to our stock of plants of *C. Calisaya*, than in acknowledgment of the very courteous and liberal spirit evinced by the Dutch authorities." * At about the same time Mr. McIvor also sent 100 plants of *C. succirubra* and 50 of each of the "grey bark" species to Calcutta, with a view to the establishment of a chinchona plantation in Sikkim.

Mr. Cross's collection of seeds of *C. officinalis* of three varieties arrived at Utakamand in March 1862. By this time Mr. McIvor had discovered the best method of treatment for chinchona seeds. He sowed in very sandy soil; and while so much water was never given as to make the particles of soil adhere to each other, yet the soil was kept in a uniform medium state of moisture. In this way the seeds not only germinated soon, but came up very strong. Mr. Howard also presented the Government with a plant of *C. Uritusinga* of Pavon, a variety of *C. officinalis*, six feet high, which he had raised from seed sent to him from Loxa by Señor Riofrio. This precious plant was embarked on board the steamer on the 4th of March 1862, and arrived at Utakamand early in April. More seeds of *C. Calisaya* arrived in 1865, and seeds and plants of *C. Pitayensis* from Colombia in 1869.

* *Secretary to the Government of India, to the Secretary to the Government of Fort St. George*, Dec. 9th, 1861.

Mr. McIvor commenced experiments in planting out in the spring of 1861. In April he planted out three trees of *C. succirubra,* two under shade, and one in an open spot surrounded by brushwood and undergrowth. On the 29th of the same month the S.W. monsoon set in, and the plants under dense shade assumed a weak climber-like habit, and were injured from the leaves being cut to pieces by the constant drip from the forest trees; while the plant shaded by the brushwood continued in the most luxuriant state of health, with its leaves uninjured. In September 1861 six plants of different species were planted out in cleared spots on the highest and most exposed points of the Nedivattam site, and all of these not only bore the cold and drought without injury, but their growth was never even checked. Between May and August fifteen "red bark" plants were planted out at Utakamand. The unusual cold of December checked the growth of these plants, but did not injure them in the least. Early in January 1862 the formation of a nursery was commenced at Nedivattam, large enough for 300,000 or 400,000 chinchonæ; and 2400 were planted out.

With regard to the question of whether the chinchonæ should be planted out in dense shade of forest trees as had been the practice in Java, or in the open, it will be well to recapitulate some of the information which was collected in their native habitat in South America.

In the forests of Caravaya I observed that the plants of *C. Calisaya,* when in dense shade, were tall and weak, with few branches, and without any sign of ever

having flowered or fruited. When very slightly shaded, as on the ridge of rocks above the Yanamayu, or scarcely at all, as on the precipice of Ccasa-sani, they spread more, have a healthy appearance, and are covered with capsule-bearing panicles; while the most thriving and healthy-looking young plant that I met with was growing in the open, without any shade whatever. Abundance of light and air is a necessity for the full development of the alkaloids in the bark of *C. Calisaya*, and the trees must either grow at the edge of the forests, or else find their way to the light, by overtopping all other trees: otherwise, as is too often the case, they assume a weakly, straggling habit under the baneful influence of dense shade.

Dr. Weddell was of opinion that, during the first year or two, the soil and trunks of young trees of *C. Calisaya* should be protected from the direct influence of the scorching sun, as he had observed that plants so exposed generally appeared to have a stunted growth. He referred of course to the *Josephiana* or shrub variety of *C. Calisaya*, but their dwarfed habit must be attributed to the less fertile soil of the open grass-land in which they grow, and partly also to the great altitude, and consequently cold climate, rather than to effects of exposure to light and air. But he assured me that he would never recommend that any of the chinchona trees should be planted in the dense shade of the forest, as in such a situation the greater number would evidently soon be smothered.

With respect to the "red bark" species, there cannot

be a doubt that they should be planted in the open. On this point Dr. Spruce's observations were quite conclusive. He wrote: "The trees standing in open ground, pasture, cane-field, &c., are far healthier and more luxuriant than those growing in the forest, where they are hemmed in and partially shaded by other trees; and while many of the former had flowered freely, the latter were, without exception, sterile. This plainly shows that, although the red bark may need shade whilst young and tender, it really requires (like most trees) plenty of air, light, and room, wherein to develop its proportions."* The "grey bark" species all bear the marks of exposure to free air, cold, and sunshine; and the overspreading thallus of various *Graphideæ* on their barks indicates that the trees have grown in open situations, exposed to rain and sunshine.† The *C. officinalis* trees, in the neighbourhood of Loxa, grow sometimes in little clumps, and sometimes solitary, but always in dry situations.‡ Dr. Seemann, who visited Loxa when serving on board H.M.S. *Herald* informed me that those which he saw, bearing ripe fruit, were on the edge of thickets, entirely exposed to the influence of air and sunshine.

When planted in the open chinchonæ grow luxuriantly, yield abundant supplies of seed, and form fine thick bark, which, owing to the free exposure of the leaves to the influence of light and fresh air, contains a

* Spruce's *Report*, p. 23.
† Howard, *Nueva Quinologia*, Nos. 2 and 7.
‡ Cross's *Report*, p. 5.

large percentage of alkaloids; while, in the shade of forest-trees, they run up into tall, weak, straggling plants, with little chance of either bearing fruit, or elaborating much quinine in their bark, until some of them at length overtop the other trees, and reach that essential sunshine of which they had been so long deprived. The above considerations led to the establishment of the plants in the open, and free from pernicious shade.

The sites were selected at Nedivattam and Dodabetta with reference to the similarity of elevation and climate in those localities to the native mountains of the species which it was intended to cultivate in them, and because they have plenty of deep loamy soil. It was decided that the best method of cultivation was to plant out the chinchonæ in the open, and not only was the luxuriant and healthy growth of the plants provided for by this treatment, but it is also essential for the formation of an abundant supply of alkaloids in their bark. This process depends on the vigorous action of the leaves, and the healthful condition of the leaves is due to a sufficient supply of sunshine. Dr. Lindley says: "It is to the action of leaves—to the decomposition of their carbonic acid, and of their water; to the separation of the aqueous particles of the sap from the solid parts that were dissolved in it; to the deposition thus effected of various earthy and other substances, either introduced into plants as silex or metallic salts, or formed there as the vegetable alkaloids; to the extrication of nitrogen; and, probably, to other causes as yet unknown

—that the formation of the peculiar secretions of plants, of whatever kind, is owing. And this is brought about principally, if not exclusively, by the agency of light. Their green colour becomes intense, in proportion to their exposure to light within certain limits." *

The results of analysis of the bark, up to 1866, had fully established the fact that cultivation greatly favours the increase of febrifuge alkaloids in the bark The *C. succirubra* had been proved to be a very hardy species, likely to flourish over a larger area than any other valuable kind, and under cultivation the yield of total alkaloids became very large. It was evident that this would be the most important species for India. The *C. Calisaya* did not thrive so satisfactorily, and was not well adapted to the climate, probably owing to the drought from November to May. The *C. officinalis* flourished most remarkably well on the higher Doda-betta plantation, and it was clear that its cultivation would become very remunerative. The "grey bark" species from the Huanuco forests also did well, improving under cultivation, as their bark was found to produce the more efficacious alkaloid quinidine, instead of the chinchonine, for the yield of which they are remarkable in their native forests. Moreover, the quantity of alkaloids in the grey barks increased, under cultivation, from 1·8 to 7·5 per cent. A great mistake has, hitherto, been made in neglecting this valuable species.

In 1866, the year in which I paid my second visit

* Lindley's *Theory and Practice of Horticulture*, p. 70.

to the Nilgiri plantations,* there were 244,871 trees permanently planted out.

The three varieties of *C. officinalis* obtained by Mr. Cross from the forests of Loxa, required distinguishing names. I, therefore, proposed that the *Uritusinga* variety should be called *var. Condaminea,* because it was the original variety discovered by La Condamine; that the variety *Chahuarguera* should receive the name of Bonpland, being the identical plant figured in Plate X. of the work of Humboldt and Bonpland (the unshaded branch with capsules) *var. Bonplandiana,* and that the third should be *var. crispa.*† The species in 1866 introduced into the Nilgiri hills were as follows:—

I. *C. Calisaya.*
II. *C. succirubra* (red bark).
III. *C. officinalis:* var. *Condaminea.*
,, ,, *Bonplandiana.*
,, ,, *crispa.*
IV. *C. nitida*
C. micrantha } (grey barks).
C. Peruviana
V. *C. lancifolia.*‡

On visiting the plantations of Dodabetta and Nedivattam, I beheld a change which appeared almost miraculous. It represented a triumph which is altogether unprecedented in the annals of arboriculture. The old jungle had disappeared, and in its place were the rows of Peruvian bark trees with their graceful and beautiful

* At the special request of the Madras Government and of Mr. McIvor.

† Memorandum of Feb. 18th, 1863. The names were approved by Sir W. Hooker.

‡ From Java, from a plant obtained by Dr. Karsten.

foliage. On the heights of Dodabetta the trees of *C. officinalis* were growing healthily, and 152 acres were already planted. A building had been erected to be used in the first instance as a jail for convicts employed in clearing and planting, and eventually as a bark store. Along the Nedivattam slopes there were four plantations, called the 1st and 2nd Denison, the Kilgraston, and the Markham plantations. Altogether 284 acres were under cultivation; with the necessary buildings, roads, drains, and watercourses. On the Markham plantation a jail had been erected for 270 convict labourers, also to be ultimately used as a bark store. A fifth plantation was formed to the east of Nedivattam, near the lovely falls of Paikâra, called the Wood plantation, where 71 acres were under cultivation, and 40 more had been cleared. Finally, a new plantation had been formed in an excellent situation on the Kundah hills, far away to the westward. Here 193 acres had been cleared and prepared for planting, and the necessary buildings had been erected. Chinchona cultivation was also eagerly undertaken by many private planters on the hills. Mr. Money had obtained 900 acres in the Deva *shola* to be devoted entirely to the culture of Peruvian bark trees; Mr. Rohde had formed a flourishing estate at a place called Balmades, to the west of the Nedivattam plantations; and altogether 290,000 chinchona plants and 503 ounces of seeds had been issued to the public up to the year 1875. Balmades was commenced in 1866, and in 1868 there were 60 acres planted. Colonel Denison's plantation of Ossington

covered 400 acres; and Dr. Colvin Smith, Mr. Phillips, Mrs. Morgan, and others had also actively commenced the cultivation of Peruvian bark. Of the 85 persons who had purchased land on the Nilgiris, under the Waste Lands Rules of March 6th, 1863, as many as 50 had undertaken chinchona cultivation. The intention of Sir William Denison, the Governor of Madras, was to limit cultivation in the Government plantations to 1200 acres; 500 at Nedivattam, 250 at Paikâra, 250 at Dodabetta, and 200 in the Kundah hills. But the latter plantation was abandoned in 1872, on the ground of its distance from Utakamand and the want of roads; the trees, planted over 75 acres, being left to take their chance with the native vegetation. In 1879 there were 8947 trees alive, from 12 to 15 feet high.*

This commencement, both as regards the work of Government and private enterprise, was a great and most encouraging success. The cultivation was secure, and the Peruvian bark trees of two valuable kinds, *C. succirubra* and *C. officinalis*, had become natives of India. The next point for decision was the best method of harvesting the bark. The most obvious way was to adopt a system of coppicing. But Mr. McIvor conceived the plan of renewing the bark itself, on a system which he thus described:—

"A labourer proceeds to an eight-year-old tree, and reaching up as far as he can, makes a horizontal incision of the required width. From either end of

* These trees were ordered to be felled. The plantation had cost £4300, which sum was thus wasted.

this incision he runs a vertical incision to the ground, and then, carefully raising with his knife the bark at the horizontal incision until he can seize it with his fingers, he strips off the bark to the ground and cuts it off. The strip of bark then presents the appearance of a ribbon more or less long. Supposing the tree to be 28 inches in circumference, the labourer will take nine of the above ribbons, each $1\frac{1}{2}$ inches wide. He will thus leave, after the tree has been stripped, other nine ribbons still adhering to the tree, each somewhat broader than the stripped ribbon and at intervals apart, occupied by the spaces to which the stripped ribbon had adhered. As soon as he has removed his strips, the labourer will proceed to moss the trunk all round, tying on the moss with some fibre. The decorticated intervals will thus be excluded from light and air, and this is one of the capital points in the system. The exclusion of light and air from a stem partially bared of bark acts in two ways; it enables a healing process to be rapidly set up in the same way as a plaster does in the case of a wound in an animal organism; and it has this farther curious effect, it increases the secretion of quinine in the bark renewed under its protection. At the end of six or twelve months the bands of bark left untouched at the first stripping are removed, and the intervals they occupied on the trunk are mossed. At the end of twenty-two months, on an average, the spaces occupied by the ribbons originally taken are found to be covered with renewed bark much thicker than the natural bark of the same age, and this renewed

bark can be removed and a fresh process of renewal again be fostered by moss. In another six or twelve months, the renewed bark of the natural ribbons left at the first stripping can be taken, and so on; harvests being obtainable from the trunk, alternately from the spaces left at the first stripping and the spaces left by the second stripping. Experience hitherto does not show any limit to the taking of these harvests from a tree. Of course, it is understood that at every stripping the ribbons taken are longer than at the preceding stripping, because the tree has each year increased in height and bulk, and therefore the top of every ribbon consists of natural bark and the lower part of renewed bark. All experience hitherto acquired shows that bark invariably renews. It renews easily and early when the cambium is untouched. In cases where the cambium is injured, the renewal proceeds, but the process is slower. In respect of universal renewal, there is no difference whatever between the red and crown barks."

This mossing process for renewing the bark must be conducted by skilled and careful men under constant European supervision; and is not, therefore, adapted for general use. It is also believed that there is a transferrence of alkaloids from the untouched into the renewed bark, and that while the renewed bark is enriched, the natural bark, which is allowed to remain, is impoverished.

The coppicing system consists in cutting down the trees near the ground, and allowing one or more of the

crops of shoots, which rise from the stumps, to grow. The results of analysis appear to show that in *C. succirubra* the trees attain their maximum yield of alkaloids in their eighth year; and under the coppicing system, they would therefore be felled during their eighth year. From the stumps two or three shoots would be allowed to grow, which would in turn be felled, and a continuous series of crops of bark would thus be gathered from a plantation treated on the coppicing system.

Mr. McIvor was of opinion that more bark could be taken from a tree, in a given time, by the mossing than by the coppicing system; and his opinion was formed after a series of experiments. Dr. King has suggested that it may pay best to take a crop of bark from a tree by mossing and then to subject it to coppicing. These questions will not be finally decided until experience has been acquired during a longer series of years.

The trees are barked at the proper season by coolies, to whom the felled stems and branches are made over as soon as they are cut. Provided with a stout knife, the coolie first marks the bark off into long narrow strips by putting his knife under it and pressing upwards. The end being freed, the remainder of the strip readily comes off. The bark is then laid to dry in sheds fitted with open shelves made of split bamboo. At Dodabetta the old jail is used as a drying-house, and the bark is dried on stages with hot-air flues—1500 lbs. at a time. When thoroughly dried the bark is stored.

The cultivation and harvesting of the bark progressed

prosperously from the time of my visit to the plantations in 1866 to the date of Mr. McIvor's death, which took place ten years afterwards. In 1866 the *C. succirubra* trees began to yield seeds, and the other species followed soon afterwards; and in 1870 the limit of planting was reached. At about the same time an important question arose with reference to hybridisation. It was in 1869 that a new variety was first observed in the Dodabetta plantations with much narrower leaves than its neighbours. On analysis its bark was found to yield the unprecedented quantity of from 7 to 10 per cent. of quinine, and 11 per cent. of total alkaloids. It was named *C. lanceolata* and *C. angustifolia.* In 1873 a still more valuable hybrid chinchona was discovered, which threw the *C. angustifolia* into the shade. It yielded 12·2 per cent. of total alkaloids, and was believed to be a cross between *C. Calisaya* and *C. officinalis.* This precious variety received the name of *C. pubescens.* The appearance of these extraordinary plants with their enormous yield, indicated the importance of paying close attention to the phenomena of hybridisation, and of studying the subject with a view to future improvements in cultivation. This is one of the points which need elucidation in the future.

At present the *C. succirubra* and *C. officinalis* greatly preponderate, and will be the main sources of future bark supply for India. The former will spread over all the hill districts, bringing healing blessings to the people. The latter, growing on sites at a considerable

elevation, will be a source of wealth, and will yield the richest quinine bark of India.

Mr. McIvor died on the 8th of June, 1876, after having been for nearly thirty years in charge of the Government gardens at Utakamand, and for fifteen years Superintendent of chinchona cultivation. His monument consists in the marvellous success of that cultivation. It is indestructible, and will last for centuries. No man could desire to have a more noble monument, nor one which could more fitly and permanently record his labours.

No successor has yet been appointed to Mr. McIvor. The plantations are in charge of the Commissioner of the Nilgiri hills, with a Manager, Mr. Hillier, to keep accounts. Under the Commissioner, Mr. Rowson is Assistant Superintendent of the Nedivattam plantations, Mr. Burrows is Head Overseer at Paikâra, and Narrainswamy Naidu at Dodabetta.

In 1880 the Dodabetta plantation consists of 320 acres planted with 226,936 chinchona trees, of which 226,677 are *C. officinalis* * and the rest hybrid. It is well weeded and the trees are healthy; yielding an annual harvest of about 40,000 lbs. of bark. The expenditure is Rs. 14,246.

The Nedivattam plantation covers 301 acres, and contains 208,780 trees. Of these, 164,456 are *C. succirubra*, 43,694 *C. officinalis*, 193 *C. micrantha*,†

* And *C. Pitayensis*? The careful distinction of varieties and species seems to have ceased with Mr. McIvor's death.

† *C. Peruviana* and *C. nitida*?

421 *C. Calisaya*, and sixteen of other species. The trees planted in 1862 are 24 feet high, with a girth of 18⅔ inches. The old trees have been barked three or four times, some even six times, yielding 3 lbs. per tree. The bark crop amounts to 76,000 lbs. a year. The expenditure is Rs. 25,790.

The Paikâra plantations are divided into two parts by the river. That on the right is called the Wood plantation, and covers 72 acres, while that on the left, called the Hooker plantation, covers 154 acres. The elevation is from 6200 to 5000 feet. In the Wood plantation there are 45,758 trees, consisting of 37,779 *C. succirubra*, 7182 *C. officinalis*, and 797 *C. micrantha*. In the Hooker plantation there are 87,557 plants, of which 58,537 are *C. succirubra*, 27,909 *C. officinalis*, and 858 *C. micrantha*. The annual bark crop is 30,000 lbs., and the expenditure Rs. 10,761.

According to Captain Campbell Walker's careful enumeration,* there are 569,031 chinchona trees in the Nilgiri plantations:—

I. *C. Calisaya* (yellow bark) . . .	552
II. *C. succirubra* (red bark) . . .	260,837
III. *C. micrantha* (grey bark) . . .	1,874
IV. *C. officinalis* (crown bark) . . .	305,432
V. *C. Pitayensis, &c.* (Colombian bark). .	336
	569,031

The whole extent of cultivation, on the three plantations, is 848 acres. The yield of bark will eventually be 391,666 lbs. a year, valued at £80,208.† The

* This officer's very able and lucid report is dated July 10th, 1878.

† In 1877–78 the net profit was £28,898; and it has continued to increase each year.

expenditure is £5000,* so that the net annual profit will be considerable. The total cost since the commencement of cultivation in 1862, up to 1880, has been £160,000, including interest. The receipts have been £173,046. Thus the whole capital charge, including interest, has been paid off; and all net receipts from this year are clear profit.

A great impetus has also been recently given to private planting. In 1877–78 the number of plants distributed was 187,350, and of seeds 326 ounces; and in 1878–79 there was an immense increase, the number of plants being 604,855, and of seeds 1322 ounces. There were 4000 acres under chinchona cultivation in the Nilgiris † and Wainad.

But although chinchona cultivation is a remunerative public work, which has been more successful than any other that has been undertaken in British India, and although its usefulness to the people is second to none, the experiment is still in its infancy. The trees of two valuable species have been introduced and are established. Their produce is an important article of commerce, and confers an inestimable blessing on the whole population. Still there is much to learn before the art of cultivating Peruvian bark trees is fully understood. The questions of the best method of harvesting, of the reasons why

* 14,246 Rupees, for Dodabetta.
25,790 „ for Nedivattam.
10,761 „ for Paikâra.
50,797 „

† The area under coffee cultivation on the Nilgiris is reported to be 19,600 acres; and 8961 more taken up.

other species do not flourish, of hybridisation, of the natural laws ruling the production of alkaloids, and several others, need further close investigation. It is necessary that there should be a centre of cultivation, where these problems can be studied and whence plants and seeds may be distributed. Moreover, the existence of the trees must be secure against all private considerations, and all, even the remotest, possibility of danger. For these weighty reasons it is absolutely necessary that the Government should retain the chinchona plantations, and continue to lead the cultivation.

CHAPTER V.

CHINCHONA SITES ON THE SOUTHERN RANGES FROM PALGHAT TO CAPE COMORIN.

HAVING decided upon the Nilgiri hills as the best position for the principal chinchona plantations, I subsequently inspected the other hill regions in Southern India to which the cultivation might be usefully extended.

South of the Nilgiris there is a remarkable break in the western ghâts, through which the railway passes at Palghat; and then the Animallé hills rise up abruptly, the range continuing almost to Cape Comorin. These most southerly mountains, from Palghat to Cape Comorin, may be divided into two distinct regions for purposes of description, which are separated from each other by that extensive unknown tract of country where the sources of the Periar are still concealed from our knowledge.

The northern division of this mountainous region includes the Animallé and Palnai hills in British territory, and the extensive hill districts within the native states of Cochin and Travancor. It differs from the more southern division, by possessing several ridges with wide stretches of table-land, instead of a single

line of mountains sloping directly from their summits to the plains on either side.

I reached the foot of the Palnai hills, in the Madura district, on the 24th of November, 1860, and immediately commenced the ascent of the Periakolam ghât, on their eastern face, on foot. This ascent is exceedingly beautiful, but the undergrowth is thick grass, and the vegetation is not nearly so luxuriant as at similar elevations on the Nilgiris. The trees are chiefly *Leguminosæ*, and at an elevation of 3000 feet chinchonaceous plants commence, amongst which I observed the *Hymenodictyon excelsum*. At 6000 feet the steep ascent is covered with long grass, and trees are confined to sheltered hollows and ravines. After reaching the plateau it is necessary to scale a second steep grassy slope before arriving at the settlement of Kodakarnal, which is 7230 feet above the level of the sea. Kodakarnal then consisted of eight houses, built along the crests of undulating hills, and one of the inner slopes is clothed with a wood of fine trees and tree-ferns, from which the Tamil people have named the settlement.* Round the houses there are gum-trees, *Acacia heterophylla*, *Cassia glauca*, fruit-trees, and hedges of roses and geraniums as at Utakamand. The houses belonged to the officials of the Madura district, the American missionaries, Mr. Clarke of Madras, and the French priest of Pondicherry, who came here for short intervals of holiday and relaxation.

Mr. Ames, the Sub-Collector at Dindigal, had kindly

* *Koda*, a shade or umbrella; and *karnal*, a jungle.

given me the use of a house which he shared with Mr. Levinge, the Collector of Madura. It had a pleasant garden, whence there is a glorious view of the Madura plains, with their numerous tanks glittering in the sun; and close to the house a torrent of deliciously cold water babbles over huge boulders of rock, and finally leaps in long falls down the face of the cliffs, making a noise at night like the roar of the sea.

The Palnai* or Varagiri hills, like the Nilgiris farther north, branch out in an easterly direction from the main line of the western ghâts. United to a portion of the Animallé range at their western end, they stretch out into the Madura plains for a distance of fifty-four miles, with a medium breadth of fifteen, and an area of 798 square miles. On the south they rise very abruptly from the plains, presenting, near their summits, a perfect wall of gneiss; but on the north and east they slope down in a succession of broken ridges. The Palnais are divided into two parts: a lower series of hill and dale to the eastward, called Malmallé or Kanandaven, averaging a height of 4000 feet, and covering 231½ square miles, where there are extensive tracts of forest, some cultivation, and several villages; and a loftier region to the westward, 6000 to 7500 feet above the sea, with undulating grassy hills and mountain-peaks, the highest of which, Permanallé, attains an elevation of 8000 feet.

The formation is gneiss, interstratified with quartz, and traversed by veins of felspar; and the rock is

* Literally "Fruit-hills."

generally decayed to a considerable depth on the plateau, and disintegrated so as to form a gritty clay. In the eastern part the soil is a light reddish loam; but on the western and loftier half it is very poor, being a heavy black peat, several feet thick, with a stiff and plastic yellowish clay as a subsoil. The rains on the Nilgiri hills have the effect of mixing the decaying grass with the decomposed rock, and a rich soil is thus formed; but on the plateau of the Palnais this operation does not appear to take place, the one becoming a black peat, and the other a stiff clayey subsoil. These remarks, however, only apply to the interior valleys, for on the outer slopes, overlooking the plains of Madura, there is plenty of good soil, and magnificent forests clothe the mountains at the foot of the perpendicular walls of gneiss which form the southern ridge of the Palnais.

The climate of the Palnais, as regards temperature, very closely resembles that of the Nilgiris. At the time of my visit, in the end of November and beginning of December, the season was very late, though there were thick mists and showers of rain every afternoon. This is the time of the north-east monsoon, and the streams swell to torrents after every shower During the first two months in the year it is very cold, and the ground is often covered with frost on the upper plateau. In March there are light showers of rain, which increase during April and May, and continue with strong westerly winds, until October. Thus the Palnais are within the influence of the south-west

monsoon.* In June and July, the warmest months, the thermometer never falls below 50°, nor rises above 75°; and the westerly winds, with occasional rain, continue during August and September.

The eastern part of the Palnais, called Kanandaven, and Pumbari, the principal village to the westward, are inhabited by people of the Kanava and Karakat Vâlala castes, numbering about two thousand of both sexes. The villages are chiefly on the lower Palnais, and one which I visited, called Vilpati, was surrounded by terrace cultivation of mustard, garlic, *ragi*, and *kéré* or amaranth. The people also cultivate *lablab*, limes, oranges, and plantains; and I heard that in one or two villages there were small coffee-gardens. Many low-country natives are also settled on the Palnais, chiefly men outlawed from their castes; and in the more inaccessible forests are the Poliars, a race of timid wild men of the woods. They have no habitations of any kind, but run through the jungle from place to place, sleep under rocks, and live on wild honey and roots. The women run with them, like wild goats, their children slung on their hips. The Poliars occasionally trade with the country people, who place cotton and grain on some stone, and the wild creatures, as soon as the strangers are out of sight, take them and put honey in their place, but they will allow no one to come near them.

The undulating hills and valleys of the interior

* Yet I missed the *Berberis Mahonia*, which in the Nilgiris is not found beyond the limits of the south-west monsoon.

plateau are covered with an aromatic grass (*Andropogon*), which grows in large coarse tufts, like the *Stipa ychu* in Peru; and it is not until the young tender shoots come out that it affords good pasture for cattle, of which there was then a small herd on the hills, belonging to American missionaries and others. The grassy slopes are dotted with tree Rhododendrons, Gaultherias, Osbeckias, Lobelias, the *Hypericum Hookerianum*, and brake ferns. This upper plateau is admirably adapted for the growth of English fruits and vegetables. In Mr. Levinge's garden there were bushes of fuchsias, daturas, roses, and geraniums; and behind the house grew peach, apple, plum, and loquot trees, strawberries, potatoes, green peas, and artichokes.

Where there are springs or water-courses on the higher range, there are generally fine-wooded "*sholas*" facing inwards, and very extensive tracts of forest on the outer slopes; but the timber, especially teak and blackwood, has been very extensively cut by the people of the hills. I examined a shola called Minmurdi-karnal near Patur, on the south side, another between that and Kodakarnal, and two others, and observed trees of the following genera: *Michelia, Cinnamomum, Dodonæa, Millingtonia, Myrsine, Monocera, Symplocos, Bignonia, Crotalaria, Passiflora, Osbeckia, Jasminum, Hedyotis, Lasianthus, Canthium,* and *Hymenodictyon.* Tree-ferns abound near the streams, and in some of the jungles there were trees of enormous size. Early one morning I went to see the "pillar-rocks," three miles to the westward of Kodakarnal.

They consist of grand perpendicular cliffs descending from the grassy heights, with their bases clothed with forest. Two of them are separated by fissures from the main cliff, and have the appearance of gigantic columns. It was altogether a most magnificent sight, with volumes of fleecy clouds rolling up from the low country, and occasional peeps of the far-away plains and glittering tanks through their folds.

The natives had long been in the habit of recklessly felling the most valuable timber, and acres of fine shola used to be annually destroyed to make clearings for plantain and cardamom groves. For the latter, however, only the small trees and underwood are burnt on the Palnais, the larger trees being left standing. But this wasteful destruction of timber was checked by the authorities, and in 1860 an acting Conservator of the Palnai forests was appointed, with a small staff, to prevent the reckless cutting of timber, and to mark, from year to year, the trees which arrive at sufficient maturity, and are fit to be felled.

I came to the conclusion that in several of the wooded *sholas* the chinchona plant might be cultivated with advantage; the *C. officinalis*, and other species which thrive at great elevations, on the upper plateau, and the *C. succirubra* in Kanandaven. Mr. Levinge, the Collector of Madura, accordingly obtained twelve chinchona plants from Utakamand in March 1864. They were planted in his garden at Kodakarnal in the following April, at a height of 6985 feet above the sea; and when I paid my second visit to the Pulnai hills, in

December 1865, I found a good beginning and every prospect of satisfactory progress. The trees were already from 4 to 5 feet high. The cultivation has since been tried in several other localities on these hills, especially by the Catholic missionaries, and the experience has been that the trees grow fairly, but that the bark is not very rich in alkaloids. In 1872 there were several hundred healthy chinchona trees in the mission-house garden at Kodakarnal. Mr. E. A. Campbell had also planted an acre with chinchona trees on the Sirumallay hills, in the Madura district, in 1870, and an acre on the Lower Palnais. The elevation of Mr. Campbell's plantations is about 3500 feet above the sea. At present there are said to be 1560 acres under coffee in Madura, but there is no complete account of the extent to which their proprietors have planted chinchona trees.

On the wilder Animallé hills, to the westward, there is an extensive area for future planting; and every species will flourish at the various altitudes from 7000 to 3000 feet. Farther south, within the Travancor territory, there is a mountain tract between the plains of Travancor and Madura, which is watered by the river Periar from south to north, the river eventually turning west and falling into the Cochin backwater. In 1865 I inspected a portion of this region called Pírméd, with Dr. Cleghorn, the able Conservator of Forests in the Madras Presidency. Our route passed right over the range from the Travancor coast, crossing the river Periar, into Madura.

The road to the hill station of Pírméd commences at Kotium, on the Cochin backwater, and passes over undulating country, covered with forest, to the foot of the mountains, a distance of 33 miles. After a beautiful ascent the region called Pírméd is reached, a country of grassy slopes, splendid forest lands, rocky ridges, and lofty peaks, averaging a height of 3000 feet above the sea. At its western edge, whence there is a glorious view of the 30 miles of forest as far as the backwaters and the sea, Mr. Maltby, formerly Resident of Travancor and Cochin, built a house, which he called Maryville, and established a chinchona garden for the Travancor Government. This was in 1862.

The Rajah granted Rs. 1000 for a garden and glass-house, Rs. 300 for getting chinchona plants from the Nilgiris, and Rs. 40 a month for a gardener and coolies; and in December 1861 Mr. Maltby wrote a most interesting memorandum on the subject. "The garden," he then said, "may be viewed as formed to aid in the introduction into the mountainous country of Travancor of the chinchona plant, and its other objects may be considered as subordinate to this, such as the growth of tea and coffee. The question is, how the Travancor Government can most successfully second the efforts of the British Government, and make due use of its mountain region in extending chinchona cultivation. There are mountains near Maryville on which subsidiary plantations may be formed up to nearly 6000 feet. Extensive seed beds should be formed, and there should be about 10 acres of coffee.

By selling the seedlings to planters, at a yield of half a ton an acre, the profit would probably cover the cost of the garden. Tea should be raised in the same way; and the towns on the coast might be supplied with potatoes and onions. The Maryville garden was commenced by planting apples, pears, grapes, oranges, strawberries, raspberries, roses, geraniums, fuchsias, and kitchen vegetables."

On December 11th, 1861, the four first chinchona trees were planted by Mr. Maltby at Maryville; a *C. Peruviana* in the north-east corner, a *C. succirubra* in the south-east, a *C. nitida* in the south-west, and a *C. micrantha* in the north-west. But his admirable suggestions were very inefficiently followed out, after ill-health unfortunately obliged him to retire in 1862. Mr. Newill, the Resident in 1865, furnished us with the following memorandum, dated December of that year:—"The Government garden at Pírméd was established about three years ago. In March 1863, about 500 chinchona plants were brought from Utakamand by Mr. Hannay, the Superintendent of the Sirkar garden. They were then about two months old, and from one to two inches high. Many died when quite young, from the effects of damp, drought, or cutting winds. There are now about 220 strong and healthy plants, and some 200 young plants have been propagated. The *C. officinalis* has a tendency to throw out branches along the ground, like a creeper. The tea plants are now three or four feet high, and seeding freely.

"So far the experiment has been encouraging, and it seems desirable for the Sirkar to pursue it so far as to provide the means for planters to try it on a more extensive scale, though I question the expediency of the Sirkar entering into extended operations, which may be left to the enterprise of others."

In December 1865 we found 225 chinchona plants growing at Maryville. They were looking vigorous and healthy, although the leaves and some of the branches had suffered severely from the cutting land winds of the north-east monsoon. The elevation above the sea is 3300 feet, and the rainfall varies from 125 inches on the western skirts to 40 inches on the eastern crests of the ghâts. In 1869 the plantation contained 3552 trees, and in 1870 the reports were still satisfactory, so that a good nucleus of chinchona cultivation is thus established in Travancor.

The coffee estates, the first of which was established in 1862, are from a mile to four miles north-east of Maryville, and in 1865 they were rapidly taking the place of the beautiful natural *sholas*. In that year 3400 acres had been granted, 625 were cleared, and 290 were already planted. In 1880 there are 32 coffee estates, covering 2500 acres.

All the country occupied by these coffee planters is well adapted for chinchona cultivation. The tract fitted for coffee extends from the crest of the ghâts to a range of hills about three or four miles further to the eastward, and for many miles to the north and south. The country is intersected by well-wooded ranges of

hills, occasionally running up into fine peaks, such as Amrita-mulla, overlooking the low country, which is 4700 feet above the sea; the Anakonum peak, overhanging the Woodlands estate; and several others. The scenery is exceedingly beautiful. The undulating hills are covered with tufts of lemon and elephant grass (*Andropogon*), growing to a height of six or eight feet, and the valleys and mountain-sides are clothed with fine *sholas*. Unlike the comparatively stunted stems and umbrella-like foliage of the Nilgiri and Palnai hills, the trees in the Pírméd *sholas*, at a lower elevation, grow to a great height and present a grand appearance. The undergrowth beneath them consists of cardamom, wild ginger, zedoary, rattan, a small bamboo called *ítah* by the natives, and a few ferns. The following are the principal trees: the *Parl-murum* (*Isonandra acuminata*), a large tree only recently discovered by General Cullen, much used for planking; the *Nanga*, called by the planters "iron-wood," appears to be a sort of poon; *Anjeli* (*Artocarpus hirsutus*), yielding a very valuable timber; *Aranili*, a tree of the jack tribe, from the bark of which bags are made; *Terminalia Catappa*, or Indian almond; *Erythrina Indica*, at the edges of the sholas; wild cinnamon; two species of *Eugenia*, and some other *Myrtaceæ*; two kinds of *Garcinia*, or gamboge trees; and the *Canarum strictum*, or black dammer tree, called by the natives *Congilium-marum*. Besides the *Eugenias*, there are several other beautiful flowering shrubs outside the sholas, but still under the shade of their trees, such as *Osbeckia*,

Crotalaria, and the brilliant dark blue *Torenia*, so common on the Sisapara ghât. These fine *sholas*, with their valuable timber, were fast disappearing under the axe of the planters, and the loud crash of falling trees was constantly heard on the hill-sides. The sites best adapted for chinchona planting are the forest slopes beneath the peaks called the Tumbis, and within Mr. Clarke's estate. They are well sheltered from the cutting land winds, and partially so from the south-west monsoon, while the numerous mountain streams supply abundance of water.

The range south of the Palnai hills and Pírméd is a single ridge dividing Travancor from Tinnevelli. Near Cape Comorin isolated masses of weather-beaten rock rise abruptly from the plain, and form an outline of battlements and pinnacles against the sky; the continuous range only commencing north of the Aramboli Pass, where the mountains attain a height of 3000 feet and upwards. The range is not broad, and has little or no intermediate table-land, but abruptly slopes from the summit ridge to the rich green expanse of Travancor on the western, and the dried-up plain of Tinnevelli on the eastern side. Several coffee estates have been formed on these hills. The most southerly is Asambhu, at an elevation of 3000 feet, immediately above the Aramboli Pass, where General Cullen, who was Resident of Travancor from 1840 to 1860, originally formed a coffee garden. Plantations were afterwards established by Messrs. Grant and others. They have been successful, the

principal drawback being the exposure to severe gales of wind, which do much injury to the plants. Farther north, on the Tinnevelli side, at the feet of two grand precipices called Maha-Indra-giri and Trivanamullay, there was, in 1865, a small coffee estate owned by a wealthy Muhammadan; and a fine tract of forest land had been purchased, but not then cleared, by General Sim, beneath the peak of Agastya-mullay. Other tracts, adapted for coffee, had been granted to planters round Courtallum and Popanassum.

There is a notable difference between the climate on either side of these ghâts. On the west side the slopes are abundantly watered by the south-west monsoon, and the streams fall into the backwater, supplying the narrow strip of land with water in abundance. On these Travancor hills clearing may be carried on to any extent, without detriment to the low country, which could well dispense with some of its surplus moisture. But, on the east side, the due supply of water for the tanks and channels is a necessary of life to the people inhabiting the wide plains of Tinnevelli. Indiscriminate fellings on these eastern slopes would lead to most deplorable results, and the evil is already beginning to be felt. Farther grants of land were prohibited in the Tenkasi taluq, and in Nanganari the people complained bitterly of the drying up of the streams.

Chinchona plants will be hereafter cultivated on all the coffee clearings and other lands that I have enumerated, and it should be remembered that their

beautiful foliage will be even more effectual in wringing moisture out of the passing clouds than the original jungle. The natives are well acquainted with the value of quinine, and when the trees which yield it are growing round the base of that magnificent peak, 6000 feet above the sea, which is dedicated to their great Rishi and physician, Agastya, they will fully appreciate the blessing that has thus been brought to their doors. Severe gales of wind cause the chief difficulty in commencing cultivation on these mountains, especially on the exposed slopes of the Agastya-mullay, but the chinchona trees, when they once get through the first two or three years of their growth, will not suffer irreparable damage from this cause. Experimental plantations were formed on the Tinnevelli hills at various elevations from 2700 to 4300 feet, and under various conditions of exposure and soil. Some trees were planted on virgin forest cleared for the purpose, others were put in grass-land. In 1866 there were thirty-two plants of *C. succirubra* and ninety-eight of *C. officinalis* planted near Popanassum, at an elevation of 3000 feet, and by 1870 the tallest had reached a height of 13 feet. The plants flourished almost in a wild state, without receiving any special care; but there are also three cultivated chinchona gardens in the Tinnevelli district. The area under coffee in Tinnevelli is reported to be 2119 acres.

On the Shervaroy hills, in the Salem district, which are beyond the reach of the south-west monsoon, and only receive their rains from the eastern coast, the

chinchona plants flourish. The cultivation was first introduced by Mr. Arbuthnott, and the hundred seedlings of *C. succirubra*, which were planted on the Shervaroys in October 1866, have since grown very satisfactorily. There are said to be 9677 acres under coffee cultivation on the Shervaroy hills.

CHAPTER VI.

WAINAD.

THE view from the chinchona plantations of Nedivattam and Paikâra extends over the district of Wainad, which is the continuation of the range of the western ghâts connecting the Nilgiris with Coorg. In this direction I confidently anticipated that the cultivation of the febrifuge trees would spread; for while fevers are excessively prevalent, the elevation and climate are suitable for the growth at least of *C. succirubra* and *C. micrantha*, and the antidote would thus be furnished in the very home of the disease.

The taluq or district of Wainad is a plateau, averaging an elevation of 3000 feet above the sea, in the direct line of the western ghâts, between the mountain knot of the Nilgiris on one side, and that of Coorg on the other. It is about 60 miles long by 30 broad, and contains an area of some 725,000 acres. On the Malabar side, the upper half of the mountains consists of a succession of stupendous mural precipices, broken here and there by ravines and spurs, and, wherever there is a foothold, the ground is covered with magnificent forest trees, many of them yielding valuable timber. On this western side there are

several mountain masses which rise from the plateau to a height of 5500 and even 6000 feet, their sides clothed with forest, and terminating in well-defined peaks. One of these, the Veleri-mulla, extends far out into Malabar. The others are the Chumbra, the Kalpetti, the Kucha-mulla, and the Balasor hills. Their northern aspects are well adapted for chinchona cultivation, while their southern slopes, receiving the full force of the south-west monsoon, are less favourable. Their rainfall is about 160 inches annually. The scenery of this western part of Wainad is exceedingly beautiful, consisting of precipices of gneiss, rising out of forests clothed in many varied tints, rapid torrents and waterfalls, and wide views of the low country. From the western mountains the land slopes gradually down to the Mysor frontier, in a succession of ridges or low ranges of hills, intersected by swamps or flats, which, when left to nature, are overgrown with *Pandanus*, but which are now for the most part covered with paddy cultivation. The ridges and hills consist of long stretches of grass-land, dotted over with clumps of bamboos, mango trees with wide-spreading branches, and flowering shrubs, such as *Solanum Indicum*, a *Crotalaria*, a *Lobelia*, called by the planters wild tobacco, and an *Osbeckia* with a very pale purple flower. The leafless but bright-flowered *Erythrina*, and the wooden-fruited *Bignonia xylocarpa*, are also common. If the bamboos were absent, the central part of Wainad would look like a beautiful but neglected English park. Occasionally isolated masses

of gneiss rise from the plateau, some, like the hills of Nelialam, ending in needle-like peaks, others forming craggy precipices. These are the Nelialam hills and Cheramkota in South-East Wainad, Cunjithkota, Yeddakul near Sultan's battery, the Minangadi rock, Jiganabetta near Kalpeti, and the "Central Hill" of Wainad. All these are conspicuous landmarks. The eastern side of Wainad up to the Mysor frontier consists of a belt of dense forest, here and there intersected by paddy flats (they call these low swampy valleys on each side of a stream *paddy flats*, whether they are actually cultivated or not) for a width of 15 or 20 miles. The climate is here much drier than on the western side, and the trees, consisting chiefly of the deciduous teak, are stunted and undersized. There are extensive fires in the dry weather, when the traveller may ride for miles through a hideously desolate forest of trees with charred and blackened stems and leafless branches. The bright little *Indigofera pulchella* by the road-side alone relieves the dreariness of the scene.

The drainage of the Wainad district, excepting the torrents which dash down the western mountains during the south-west monsoon, is entirely to the eastward, the numerous streams uniting to form three rivers, which are tributaries of the Kaveri. The Moyar drains South-East Wainad and part of the Nilgiris, the Nugu drains South, and the Kubani North Wainad. All the streams are fordable in the dry season, though the banks are often steep; but during

the monsoon they swell to an immense size, often rising 30, with a width of 200 feet, and dashing furiously along with masses of tangled branches and uprooted trees.

The original inhabitants of Wainad, before the planting brought in an influx of strangers, belonged to various races. The lords of the soil were generally Nairs of the Malabar country, some of whom were petty princes, and laid claim to very extensive tracts of land. Such was the Numbulakotta Varnavar in South-East Wainad. A large body of smaller proprietors, of the Chetti caste, were also scattered through the district. The working class was a slave race called Punniers, a short and sturdy people, with very dark complexions and curly hair. The wild tribe of Kurumbas inhabited the forest tracts. The Nair and Chetti proprietors generally build their houses on picturesque knolls adjacent to their paddy cultivation. Clumps of mango and jack trees, plantains, and sago palms are planted on the knolls as garden cultivation, and the Punnier slaves are hutted round the houses of their lords.

But, before coffee planting commenced, Wainad, with the exception of a few patches of cultivation, was a wild and little known region, with a detachment of native troops at Manantawadi to overawe the Nairs and Moplahs. Its products were cardamoms, elephant ivory, wax, honey and timber.

Coffee planting commenced in Wainad in about 1840, and I believe the first plantation was on the

Club Hill, at Manantawadi. In South Wainad the first plantation was opened in 1846. In 1866 there were upwards of 200 coffee estates in Wainad, covering 14,613 acres, of which 9865 belonged to Europeans, and 4748 to natives. There are now (in 1880) reported to be 32,000 acres in Wainad occupied by mature coffee plants, 10,000 by immature plants, and 27,000 taken up for coffee, but not yet planted. The average yield is 200 pounds per acre, and the average cost of cultivation, Rs. 250 per acre. A great and important interest has thus sprung up in Wainad, many thousands of pounds have been sunk in it, and very greatly increased wealth has resulted to the neighbouring countries of Malabar and Mysor.

Wainad is approached from the side of the Malabar by three principal ghâts. South-East Wainad, at the foot of the chinchona mountains of the Nilgiris, is reached from Calicut by a voyage up the Beypur river to the Conolly teak plantation, and thence up the Karkur ghât.

The Conolly teak plantation is near the foot of the mountains, and in 1866 it extended for seven miles along the north, and for several miles along both sides of the Beypur river. The long vistas of tall and perfectly straight trees presented a striking appearance. The stems were often without a branch for a height of 70 feet and upwards. The planting was commenced in 1840, and I found those planted in 1843 to be 5 feet 2 inches in girth at a distance of 3 feet from the ground, and 90 feet high. Several acres were

planted every year. The finest view of the plantations is from the bed of the river, where there is a foreground of drooping feathery bamboos, above which the stately teak trees appear with their large green leaves, while the line of the Nilgiris, crowned by the needle-like peak of Makurti, bounds the distant view. In 1874 the total outlay had been £22,900, of which £10,100 had been repaid by thinnings, making the net cost of the plantations £12,800. But if interest is taken into account, the debt against the plantations was £23,500. The annual revenue from thinnings is £1000 and the charges £500. The real returns will begin when the trees are 50 years old. The area of the plantations, in 1875, was 2730 acres.

In the surrounding forests, which are broken by open glades, there are several kinds of useful timber trees. Among them I noticed the *erul* or *jambay* (*Xylocarpa Indica*) with pods of hard wood; the *karamarda* (*Terminalia coriacea*), called "jungle-wood," with bark very rough and cracked in squares, like a tortoise's back; the *pillamarda* (*Terminalia chebula*), or "white tree;" and the *ben-teak* (*Lagerstomia microcarpa*), which grows to a good size, and yields timber used for raftering and flooring.

From Nelembur the road leads through a jungle of fine trees to Yeddakara, a bungalow in a large open expanse of grass surrounded by the forest. Here there was an encampment of *Brinjaris* (correctly *Banjárás*), the carriers of the country, with 500 bullocks bringing down coffee: most of the men and boys suffering more

or less from fever. We gave them quinine, and, under a bright starry sky, an old man played while his bullock boys sang part-songs. Next day, January 22nd, 1866, I walked up the Karkur ghât and along the road which crosses South-East Wainad into Mysor. Gúdalur is the chief station in this division of the district, at the foot of the ghât which leads from the Wainad plateau by the Nedivattam plantation to the Nilgiris. On either side of the road there were, in 1866, upwards of sixty coffee plantations, the best being at Cherambadi and Devala, near the western edge of the plateau, and in the Ouchterlony Valley,* at the foot and on the slopes of the Nilgiris. This valley is now one mass of coffee estates; while the Cherambadi and Devala estates cover a succession of undulating hills, on the upper slopes of the western ghâts overlooking Malabar. Other coffee plantations cluster round the Nelialam hills, and round Gúdalur, which is the central point of South-East Wainad.

The south-east division is very feverish, and here, more than in almost any other part of Southern India, will the blessings of chinchona cultivation be felt. In 1864 fever ravaged the neighbourhood of Gúdalur and carried off many hundreds of people; and this terrible

* Most of the land in the South-East Wainad originally belonged to a large Nair proprietor called the Varnavar of Numbulakota. He was in debt, and in 1836 his territory was sold, by a decree of the Zillah Court, and bought by the principal mortgagee, the Terapad of Nelembur. The Terapad made a grant of a very large tract of this land, at the foot of the Nilgiris, to Mr. Ouchterlony, which is now known as the Ouchterlony Valley.

visitation suggested the establishment of a dispensary. The planters subscribed liberally, and the Government undertook to contribute an apothecary and medicines. The dispensary was opened on May 1st, 1865, and up to the end of that year it had received 116 in-patients, while 1700 out-patients had been treated. Gúdalur is a village numbering about 150 houses, 3600 feet above the sea. The Gúdalur fevers are chiefly of the intermittent type, beginning in February, becoming a regular epidemic after the early rains (mango showers) in March and April, and ceasing gradually on the setting in of the south-west monsoon.

The boundaries of South-East Wainad are the Mysor frontier on the north, the ghâts overlooking Malabar on the south, the river Nugu dividing it from South Wainad on the west, and the Nilgiris towering above it on the east.

South Wainad is the most important division of the district, containing, in 1866, upwards of sixty coffee estates, chiefly along the edge of the ghâts, but with northern or western aspects, or around the slopes of the Chumbra and Kalpetti hills. The farther a coffee plantation is from the moisture of the western coast, the less profitable is its yield of coffee. The approach to South Wainad from the sea-port of Calicut and Tellicheri, leads up the Tambracheri ghât to Lakadi and Vaitari, and thence crosses the plateau to Sultan's Battery and the Mysor frontier. The Tambracheri ghât is a rocky forest-covered slope, up to within 500 feet of the summit, and then a sheer precipice of very hard

gneiss. The chief station of South Wainad, called Lakadi, is at the head of the ghât, and the road passes through it and across the plateau, with coffee plantations on either side, to Sultan's Battery.

This village of Gunputty-wutun, or Sultan's Battery, occupies a very central position in Wainad. The line of road across South Wainad, from Malabar to Mysor, passes through it, as well as that from the Nilgiris, through Gúdalur, and along the whole length of the Wainad plateau to Manantawadi. The name of Sultan's Battery is derived from a square enclosure surrounded by a ditch, where Tipu mounted some guns; whence he took shots at a temple hard by, where there was a stone carved into the shape of the elephant-headed god Ganesa (or *Gunputty*). Here there is a large bazar, and the place is surrounded by fine clumps of trees, native coffee gardens, and paddy cultivation. The distance from Sultan's Battery to the Mysor frontier is fifteen miles, and to Lakadi thirty miles.

North Wainad is traversed by the old pioneer road from Mangalor, up the Periar ghât to the Mysor frontier at the Bawalli bridge. It is separated from Coorg by the Bramagiri mountains, on the summits of which there is a plateau 6000 feet above the sea. Parallel to them runs another well-wooded range, called the Dindimul hills. The chief station in North Wainad is Manantawadi, whence there are coffee estates all along the road to the Periar ghât, and along the slopes of the Dindimul hills. Coffee cultivation also extends on the eastern side of Manantawadi almost to the Bawalli bridge,

while in the north-east there were thirty plantations along the slopes of the Bramagiri mountains, and in the Tirunelli valley. But on the eastern side of North Wainad, called "the bamboo side," the soil is poor, and the climate is too dry. The land yields two good crops, and then falls off, requiring manure. In 1866 there were fifty-three coffee estates in North Wainad.

Before coffee planting commenced in Wainad the labouring class consisted of the Punniers, those curly-headed slaves of the Chettis, who have, for the most part, preferred the old bondage under their hereditary masters to service on coffee estates. The planters, therefore, have to look abroad for their labour. Demand soon creates supply, and many thousands of coolies now annually come in from the villages of Mysor, and up the ghâts from Malabar. The wild Kurumbas also occasionally engage themselves, and on the Bramagiri estates there are some families of very good labourers belonging to a slave caste from Coorg. But the great mass of the labour comes from Mysor and Malabar.

The planters have to supply the coolies with suitable lines near their work, generally of split bamboos plastered with mud, and the health and comfort of the coolie and his family is, of course, an important consideration for the planter, as his supply of labour in a great measure depends on it. After the crop is picked, the coolies return to their own homes, to see after their own crops and spend their money, returning to Wainad for the weeding and other work on the coffee plantations during the monsoon. The usual method of obtaining

labourers is to employ a native *maistry*, who engages to enlist a fixed number of coolies, and bring them to the estate from their own homes, with an agreement to work for a certain fixed sum, and the *maistry* receives a large sum of money in advance. No less than 100,000 labourers were employed on the Wainad coffee estates in 1866.

My great anxiety for the successful introduction of chinchona cultivation into Wainad, and the naturalisation of the Peruvian bark tree there, arose from the terrible prevalence of fever and the high death-rate among the labourers on the coffee estates.

My conclusions were favourable to the successful cultivation of the *C. succirubra*, the species which yields the highest percentage of total febrifuge alkaloids. Along the ridge of the Western ghâts overlooking Malabar, several grand masses of forest-covered mountain rise from the Wainad plateau and terminate in peaks at elevations of from 4500 to 5000 feet. The most remarkable of these mountain-knots are the Velerimulla, the Chumbra, the Kucha-mulla, and the Balasor ranges, as well as the Bramagiri mountains, forming the boundary between Wainad and Coorg. The sites best adapted for chinchona cultivation are to be found along the more sheltered slopes of these ranges.

In 1866 the growth of chinchona trees in Wainad had already been commenced; and I found that there were plants on a number of estates, in all the divisions of the district.

But, although the extension of this cultivation on the estates of European planters was much to be

desired, it seemed to me to be equally important that the natives of the district should be induced to open small chinchona gardens in every direction, and in great numbers, as the people suffer fearfully from fever. I myself witnessed its ravages, and much of this terrible evil might easily be mitigated. The Chettis, Nairs, and Moplahs, who occupy land in Wainad, generally select elevated knolls for the sites of their dwellings, which are exceedingly picturesque. They are covered with jacks, mangoes, bastard sago palms, and plantains, and overlook the rich paddy cultivation in the flats below. In most of these sites chinchona trees would grow well, and form another item in the garden produce of the people. The healing febrifuge would be at their doors, and the use of the bark would be extended to a district where hundreds of slaves and coolies formerly died on the public roads for the want of it. An unspeakable blessing, such as only those who have witnessed the ravages of fever amongst the coolies can fully appreciate, would thus be conferred on the Wainad district.

Since 1866 many of these early attempts have borne fruit. There are now several chinchona plantations in Wainad, and the analyses of the bark of *C. succirubra* grown in the Cherambadi district, on Captain Cox's estate, are considered by Mr. Howard to be very promising. The fever-healing tree may now be looked upon as naturalised on the fever-haunted plateau of Wainad; and the Wainad bark has taken a regular place in the London market.

CHAPTER VII.

COORG.

NORTH and west of Wainad, in the line of the western ghâts, lies the mountainous principality of Coorg, a region which I also considered likely to furnish sites for chinchona plantations. It was thought desirable that I should visit Coorg for the purpose of forming an opinion after personal inspection, and I accordingly approached the mountains from the Mysor or eastern side.

After leaving Fraserpett, at the foot of the hills, the road enters a dense bamboo jungle, extending along the base of the mountains. It was the month of January, and the forest was completely dried up and burnt by the sun and want of rain, looking brown and sombre. A splendid white *Ipomœa*, with a rich lilac centre, was creeping in festoons to the very tops of the feathery bamboos which bent gracefully over the road. At a place called Suntikupah, ten miles from Fraserpett, the ascent of the mountains begins. The road leads up and down a succession of wooded heights, which gradually increase in elevation, with intermediate valleys cultivated with rice and generally fringed with plantain

groves, through which the huts of the Coorgs are visible. At the heads of these valleys the streams are divided into two channels, and led down each side, the space between being sown with rice in terraced fields, gradually descending with the slope of the valley. These bright patches of cultivation are very pretty, their light vivid green contrasting with the sombre hues of the forest. Near Merkára the jungle is a good deal cleared, and the slopes are covered with coffee plants. The road was excellent.

Towards evening we came in sight of Merkára. On the opposite side of a deep narrow valley were the fort and palace, built on an eminence overlooking a vast extent of mountainous, forest-covered country.

The palace is entered by an archway, over which there is a balconied window supported by two white horses. The inner court is surrounded by a corridor of stone pillars, with a roof entirely of copper; and in the centre of the court there is a tank paved with stone flags, now dry, with five steps down to it, on two sides, and a carved stone tortoise in the centre.

On the south-west side of the palace there is a parade-ground, and a small amphitheatre dug out of the solid rock, where elephants and tigers fought for the diversion of the Rajah. Beyond the parade-ground the ridge on which Merkára is built abruptly terminates, and the land sinks down into a wooded valley. Here the late Rajah had built a little brick and *chunam* summer-house, whence the land descends precipitously to the road leading down the Mangalar ghât. From

this point there is one of the most glorious views to be found in India, and we sat on the grassy edge of the cliffs for hours, without ceasing to enjoy it. Right and left there is a wide expanse of forest-covered ranges of mountains extending into the blue distance, and in front rises up the mountain of Tadiandamol, the loftiest peak in Coorg. We watched the crimson sunset over the hills, and after dark a spontaneous ignition of the dry grass wound like a serpent along the loftier ridges of the opposite mountains, producing an indescribably beautiful effect in the clear starry night.

Coorg has been a portion of the British dominions since 1834, when the last Rajah was deposed.

The Kodagas or Coorgs are a tall, muscular, broad-chested, well-favoured race of mountaineers, with a population rapidly increasing since the deposition of the Rajah.* They are of Dravidian origin, and speak a dialect of Canarese; but a colony of Brahmans early settled in the country, and endeavoured to mould the traditions of the Coorgs into harmony with their own legends. These are embodied in the Kaveri Purana, where there is a romantic account of the origin of that important river, which rises in the mountains of Coorg.

In the Mahabharata it is related that the *amrit* or drink of immortality, which had been lost in the waters of the Deluge, was recovered by the Suras and Asuras, gods and demons, by churning the ocean. The Asuras are then said to have stolen it, and it was finally

* The whole population of Coorg was 168,312 in 1871.

restored to the gods by the maiden Lopamudra, who charmed the Asuras by her beauty. The fair damsel then resolved to become a river, and thus pour herself out in blessings over the earth. But the sage Agastya, so famous in the history of Madura, was enamoured of her, and she at length so far yielded as to consent to be his wife, on condition that she should be at liberty to forsake him the first time he left her alone. One day he went to a short distance to bathe, when Lopamudra immediately gratified her early longings, by jumping into Agastya's holy tank, and flowing forth as the river Kaveri. The sage, on his return, ran after her, but the only consolation that was left to him was to explain to his beloved the course she ought to take in flowing towards the eastern sea.

The Kaveri Brahmans, as persons of that caste are called in Coorg, wear the sacred thread, and perform *pujah* to the goddess of the river. They number about forty families, but are fast dying out. They are often very rich, and are employed in the pagoda, or as clerks in the Superintendent's office. The Coorgs themselves, the inhabitants of this mountainous district, are divided into thirteen castes. They generally retain the old devil-worship of the Scythic or Dravidian race from which they are descended, and are addicted to the use of charms and sorceries. They marry at a ripe age, but the wives of brothers are considered as common property. All the men wear a silver-mounted dagger, secured round the waist by a silver chain; and the women, who are often very pretty, wear a white cotton

cloth round the head, with the ends hanging halfway down the back. The men are an independent, hard-working race, tall, with comparatively fair skins. They are very keen sportsmen, and most of them possess a gun, the boys practising with pellet-bows.

Coorg consists of a succession of lofty wooded ridges and long deep valleys, forty miles broad by sixty long, between lat. 12° and 13° N. It is bounded on the north by the river Hemavati, on the south by the Bramagiri hills, on the west by Malabar and South Canara, and on the east by Mysor. South of Merkára the country appears covered with forest, wave upon wave of wooded mountain ranges rising one behind the other, the highest peak of all having its summit partially bare of trees, and covered with rich herbage. The elevations above the sea are as follows:—

Tadiandamol (the highest peak) . .	5781 feet.
Pushpagiri (another peak) . . .	5682 „
Merkára	4506 „
Virarajendrapett	3399 „
Fraserpett	3200 „

The river Kaveri drains about four-fifths of the surface of Coorg, while about a dozen streams, issuing from the same hill region, traverse Malabar and South Canara. From the end of December to the end of March rain is very scarce, but the valleys are seldom without fogs more or less dense in the evenings and mornings, and heavy dews are frequent. During these months a dry east wind prevails, which has long ceased to carry rain with it from the Bay of Bengal. Towards

the end of March clouds begin to collect, and the air grows moister. In April and May there are thunderstorms and frequent showers, with a warm and moist climate. In the end of May the clouds in the western sky grow in strength; and in June rain prevails, descending at times softly, but generally with great violence, accompanied by heavy gusts of westerly wind. In July and August the rain pours down in floods day and night, to such a degree that a flat country would be deluged; but Coorg, after being thoroughly bathed, sends off the water to the east and west by her numerous valleys. The yearly fall of rain often exceeds 160 inches. In September the sun breaks through, in October a north-east wind clears the sky, in November showers fall over Coorg, being the tail of the north-east monsoon, and December is often foggy.* As regards the annual temperature of Merkára,† the extremes range from 52° to 82°, the average being 60°.

An immense quantity of rice is cultivated in the Coorg valleys, and largely exported. Scarcely any dry grain is raised.

Coffee cultivation was only commenced in Coorg in 1854, but its extension both amongst natives and Europeans has since been very remarkable. The estates are

* *Coorg*, by Rev. H. Moegling. (Mangalore, 1855.) See also *Memoir of the Codugu Survey, commonly written Coorg*, by Lieutenant Connor. (Parts i. and ii. pp. 119 and 137.) The Survey was made in 1815 to 1817. The memoir was printed at Bangalore in 1870. Also *The Gazetteer of Coorg*, by Lewis Rice. Bangalore, 1877.

† Observations by Dr. R. Baikie. *Madras Journal*, 1837, vi. p. 342.

on the Merkára plateau and along the Sampaji and Perambadi ghâts. In 1875 there were 4235 estates covering 106,759 acres, and yielding 4234 tons of coffee, worth £270,000. The natives too have shown great enterprise in undertaking a cultivation previously unknown to them, and there is now scarcely a hut to be seen without its little coffee garden. All the plantations on the eastern side of Merkára, excepting one, belonged to natives in 1860; and close to the town I observed a small clearing where a Coorg was hard at work building himself a hut, cutting away the jungle, leading a small stream into new channels for purposes of irrigation, and planting the slopes of two hills with coffee.

It will be seen by the account I have been able to give of the elevation, temperature, and of the periods of drought and moisture in this hill district, that it is not nearly so well adapted for the cultivation of chinchona plants as Nedivattam, and many other localities on the Nilgiri hills. It may be compared, more appropriately, with the forests near Sisapara on the Kundahs, as it is exposed to the full force of the south-west monsoon, and suffers from a long drought during the winter.

The country to the north and east of Merkára is a plateau, about 4500 feet above the sea, intersected by ravines full of trees and underwood, amongst which I observed wild orange and lime trees, *Michelias*, and tree-ferns, with an undergrowth of ferns, *Lobelia*, *Ipomœa*, and *Solanum*. The scenery is charming, with

grassy slopes, wooded glades, and here and there a secluded hut in a grove of plantains, on the edge of a small patch of rice cultivation. I also examined some of the forests down the Mangalor ghât. The road is excellent, winding with a gentle gradient through the beautiful forest scenery past numerous coffee plantations to their port of shipment at Mangalor. At the fourth milestone from Merkára there was a forest extending for nearly a mile, on the left of the road, at an elevation of 3800 feet above the sea. It descended from the road to the bottom of the ravine, and on the opposite side there were forest-covered heights of greater elevation. The forest contained many tall trees, not growing very close, with tree-ferns, *Cinnamomum*, *Hymenodictyon*, *Melastomaceæ*, a *Papilionacea* with a bright yellow flower, and ferns of which I collected five kinds. The general character of the flora appeared suitable for the growth of chinchona plants; and, though this was the driest time of the year, I found at least one small stream trickling down through the underwood. The valley runs north-west and south-east.

I was of opinion that in this locality plants of *C. succirubra* would no doubt flourish, and that the experiment ought certainly to be tried; though, from the low elevation, the bark would probably be thin, and would yield perhaps a small percentage of alkaloids.

There are many other localities equally suited for the cultivation of *C. succirubra* and *C. micrantha* in Coorg; and, with so many energetic and intelligent planters

in the district, I believed that the growth of this important product would be extended and rendered profitable by private enterprise. A few rows of chinchona plants ought to be established in the loftiest part of each coffee clearing; and every settler should plant them, and encourage the cultivation among the natives, from motives of humanity, as well as with a view to successful commercial speculation.

We finally left Merkára before dawn, and rode for three miles down the steep ghât leading to the lower and more extensive valleys of south-eastern Coorg, which we reached as the sun rose. It was a very pleasant ride through the beautiful hill country, with uplands covered with fine forest, and long strips of fertile valley. In the jungles we saw immense clumps of bamboo, which overshadowed the road; a leafless and thorny *Erythrina* with crimson flowers, and a *Solanum* with a small white flower by the road-side. Here and there we came to open grassy glades, whence little foot-paths led through the neighbouring jungle to some secluded hut. The cultivated valleys were covered with rice, and fringed with plantain groves and *Caryota urens.*

The *Caryota urens* is a lofty palm tree, with large leaves, and the Coorgs draw an immense quantity of toddy from it during the hot season. The pith of the trunk of old trees is a kind of sago, and is made into bread and gruel by the natives of many parts of India. Humboldt says that the form of the leaves is very curious, the singularity consisting in their being bipin-

natisect, with the ultimate division having the shape of the fin and tail of a fish.*

We passed several hundred pack-bullocks conveying Bombay salt from the Malabar ports to the interior, and, having forded the Kaveri at a point where the bed is full of large boulders of rock, reached the village of Virarajendrapett. It consists of two clean streets, at right angles, with a missionary church and school. The mountains are here dotted with plantain groves, and nearly every house has a small coffee garden attached. The surrounding country is exceedingly pretty, the view being bounded by forest-covered mountains. The bungalow at Virarajendrapett is on the site of an old palace of the Rajahs, and the compound is surrounded by a high wall, with an ornamental gateway, flanked by stone sentry-boxes.

From this point the descent into Malabar commenced, through dense forest, with bright moonlight glancing through the branches of gigantic trees, and after a journey of fifteen miles we reached the bungalow of Utikali, in the middle of the jungle. It is in these forests, on the western slopes of the Coorg mountains, that cardamom cultivation is carried on to a great extent. In February parties of Coorgs start for the western mountains, and, selecting a slope facing west or north, mark one of the largest trees on the steepest declivity. A space about 300 feet long and 40 feet broad is then cleared of brushwood, at the foot of the tree; a platform is rigged about twelve feet up the tree,

* Seemann's *Popular History of the Palms*, p. 134.

on which a couple of woodmen stand and hew away right and left until it falls head foremost down the side of the mountain, carrying with it a number of smaller trees in a great crash.

Within three months after the felling, the cardamom plants in the soil begin to show their heads all over the cleared ground during the first rains of the monsoon, and before the end of the rainy season they grow two or three feet. The ground is then carefully cleared of weeds, and left to itself for a year. In October, twenty months after the felling of the great tree, the cardamom plants are the height of a man, and the ground is again carefully and thoroughly cleared. In the following April the low fruit-bearing branches shoot forth, and are soon covered with clusters of flowers, and afterwards with capsules. Five months afterwards, in October, the first crop is gathered, and a full harvest is collected in the following year. The harvests continue for six or seven years, when they begin to fail, and another large tree must be cut down in some other locality, so as to let the light in upon a new crop.

The harvest takes place in October, when the grass is very high and sharp, sorely cutting the hands, feet, and faces of the people. It is also covered with innumerable large greedy leeches. The cultivators pick the cardamom capsules from the branches, and convey them to a temporary hut, where the women fill the bags with cardamoms, and carry them home, sometimes to distances of ten or twelve miles. Some families

will gather from 20 to 30 mans * annually, worth from 600 to 1000 Rs.†

This method of cardamom cultivation must be considered injurious to the conservancy of fine timber in the forests; but, on the other hand, the crops themselves are very valuable, and bring in a considerable revenue. There is another kind of cultivation carried on in these vast forests on the western slopes of the ghâts, which is far more prejudicial to the production of valuable timber-trees. This is called *kumari*, and *punam* in Malabar. It as been altogether prohibited in Coorg and Mysor, while in Canara it is not now allowed within nine miles of the sea, or three of any navigable river, or in any of the Government forests without previous permission. But in Malabar, where all the forests are private property, the Government is unable to interfere in the matter, and *kumari* is quite unrestricted.

Kumari is cultivation carried on in forest clearings. A space is cleared on a hill-slope at the end of the year; the wood is left to dry until March or April, and then burnt. The seed, generally *ragi* (*Eleusine coracana*), is sown in the ashes on the fall of the first rain, the ground not being touched with any implement, but merely weeded and fenced. The produce is reaped at the end of the year, and is said to be worth double that which could be procured under

* The *man* or *maund* of S. India was fixed at 25 lbs. The Bengal maund is 87⅔ lbs.

† Moegling's *Coorg*, pp. 74–77; also Buchanan's *Travels*, ii. p. 511; and Drury's *Useful Plants of India*.

ordinary modes of cultivation. A small crop is taken in the second, and perhaps in the third year, and the spot is then deserted and allowed to grow up with jungle. The same spot is cultivated again after ten or twelve years in Malabar, but in North Canara the wild hill tribes generally clear patches in the virgin forest. Dr. Cleghorn reported that *kumari* renders the land unfit for coffee cultivation, destroys valuable timber, and makes the locality unhealthy, dense underwood being substituted in the abandoned clearings for tall trees under which the air circulated freely.* The Kurumbas and Irulas, wild tribes of the Nilgiris, also raise small crops by burning patches of jungle and scattering seeds over the ashes. This system, which sounds so wasteful and is so injurious to the yield of timber in the forests, is exceedingly profitable to the cultivator, who has no expenses beyond the payment of land-tax, which in these wild unfrequented spots is often evaded.

After leaving Utikali we still had to pass through fifteen miles of jungle, before reaching the open cultivated country in northern Malabar. In driving down the ghât the views, through occasional openings, of the wide expanses of forest were very grand. Tall trunks of trees towered up to a great height in search of light and air, palms and bamboos waved gracefully over the road, and the range of Coorg mountains filled up the background. Most of the valuable timber has

* Cleghorn's *Forests and Gardens of South India*, pp. 126–144, where the official correspondence respecting *kumari* will be found.

been long since felled in these forests, excepting in the very inaccessible parts. The poon trees (*Calophyllum angustifolium*),* which are chiefly found in Coorg, and yield most valuable spars for masts, have become exceedingly scarce. The young trees are now vigilantly preserved. Black wood (*Dalbergia latifolia*) is also getting scarce, though I saw a good deal of it in some of the Coorg jungles; and teak trees of any size have almost entirely disappeared, excepting in the forests of North Canara.

At a distance of twenty miles from the sea the cultivated country commences in this part of Malabar, and the road on each side is lined with pepper-fields, with occasional groves of plantains and clumps of cocoa and betel-nut palms. The land undulates in a succession of hills and dales, with rice cultivation in some of the hollows. Here the pepper is regularly grown in large fields, and not in gardens as at Calicut. In the first place trees are planted in rows, usually such as have rough or prickly bark—the jack, the mango, or the cashew-nut. In the country we were passing through the tree used was an *Erythrina*, with the bark of trunk and branches thickly covered with thorns. Until the trees have grown to the proper size the land is often used for raising plantains. When the trees have attained a height of 15 or 20 feet, the pepper is planted at their bases, and soon thickly covers the stem and festoons over the branches. The pepper-

* *Cleghorn*, p. 11. Poon spars are also obtained from *Stercula fœtida*, a tree with brownish flowers, emitting a most horrible smell.

cuttings or suckers are put down by the commencement of the rains in June, and in five years the vine begins to bear. Each vine bears 500 to 700 bunches, which yield about 8 or 10 sers * when dried. During its growth it is necessary to remove all suckers, and the vine is pruned, thinned, and kept clear of weeds. The vine bears for thirty years, but every ten years the old stem is cut down and layers are trained. It is an exceedingly pretty cultivation, and, if it was not for the crests of straggling branches which crown the vine-covered trunks, it would not be unlike the hop-fields of Kent.

The houses on the road were built of laterite, large and comfortable like those at Calicut. We saw the people sitting before their doors, busy with their heaps of pepper. When the berries have been gathered, they are dried in the sun on mats, and turn from red to black. The white pepper is from the same plant, the fruit being freed from the outer skin by macerating the ripe berries in water. Before reaching the port of Cannanor we passed over three or four miles of elevated rocky land, without cultivation, and arrived in the cantonment late at night.

In accordance with my recommendations, a chinchona plantation was formed in Coorg after a delay of four years, and 96 trees were planted on August 24th, 1865; while 165 were distributed to coffee-planters. The site is a short distance to the east of Merkára. In

* In S. India the *ser* is one-eighth of a *palam*, which is equal to one ounce.

1875 there were 412 chinchona trees in the original plantation; and both planters and natives had received seedlings from the nursery attached to it. The analysis of bark from the Coorg trees, in 1870, gave a good result, there being 6·23 per cent. of total febrifuge alkaloids. The tallest trees were 20 feet high, with an average girth of 28 inches, the age being twelve years. Here too, in spite of the very lukewarm support of the Government, the Peruvian bark tree has been naturalised.

CHAPTER VIII.

THE MAHABALESWAR HILLS.

THE districts best adapted for the cultivation of chinchona plants are those in the southern part of the peninsula, at suitable elevations, which receive moisture from both monsoons. The Nilgiri hills are the centre of these districts, and as we advance farther from that nucleus in a northerly direction, the rainfall from the south-west monsoon becomes heavier, while the climate of the winter, when easterly winds are blowing, increases in dryness. In 14° N. latitude the hills of Nagar sink down into the plains of Dharwar, and from that point to the Mahabaleswar hills in 18° N. there are few parts of the western ghâts which attain a sufficient elevation for the successful growth of chinchona plants.*

The Mahabaleswars, however, are upwards of 4000 feet above the sea, and it was therefore possible that they might present localities suitable for chinchona cultivation.

These hills are the loftiest part of the western ghâts in the Bombay Presidency. They form an undulating table-land of small extent, terminating to the westward

* In lat. 15° N. the western ghâts are not more than 1100 feet above the sea.

in a very abrupt descent, often forming scarped precipices overhanging the Konkan, and sloping down more gradually on the side of the Dakhin. The highest point, close to the English station, in latitude 17° 59′ N., is only 4700 feet above the sea. The English station, with a native bazar and village, was formed by Sir John Malcolm in 1828, and has received the name of Malcolm-penth. Several of the surrounding peaks are named after his daughters. The roads are excellent, and are bordered by such trees and shrubs as jasmine, figs, *Randias*, *Gnidias*, and *Crotalariæ*, with a pretty white *Clematis* climbing over them. The station is near the edge of a range of precipitous mountain crags and cliffs overlooking the Parr valley. The cliffs are broken by several profound ravines, thus forming promontories commanding grand views of the hill fort of Pratabgarh, the Konkan, and even the sea on very clear days. Good carriage-roads have been made to those points which command the best views, such as Babington, Bombay, Sydney, and Elphinstone points, all looking west. From Babington point there is a magnificent view. The station, with numerous bungalows peeping out amongst the trees to the north, is seen along the crest of a ridge which is separated from Babington point by a profound ravine. The precipitous cliffs, now dried up and barren, are scarped and furrowed by the water which deluges them during the prevalence of the south-west monsoon; but there was one bright green spot where some potatoes were cultivated in terraces, on the edge of a precipice.

The most conspicuous object in the station is an obelisk of laterite, erected to the memory of Sir Sidney Beckwith. From this point, immediately above the little thatched church, there is a good view of the station, the numerous bungalows, peeping out amongst their shrubberies, dotted about in all directions; the billiard bungalow, sanatarium, and public library, all built of laterite, standing in an open space; the native bazar at our feet; and a curiously shaped mass of mountain peaks to the south and west.

One day we rode over to the native village of Mahabaleswar, which is three miles from Malcolm-penth. It consists of a few dozen thatched huts, on the side of a wooded hill, and some very interesting temples. By the roadside, in the hedges surrounding the huts, there were roses, daturas, and jambol-trees (*Eugenia Jambolanum*) with heads of graceful flowers.

The chief temple, built at the foot of a steep hill, has an open space in front. The exterior wall is faced with pilasters painted yellow, the intermediate space being red. In the centre there is an arched doorway leading into an interior cloister, built round a tank. No European is allowed to enter, but, from the outside, a cow carved in stone is visible on the opposite side of the tank, with a stream of water pouring from its mouth. This fountain is said to be the source of the Krishna, and the temple is considered very sacred in consequence. To the right, and a little in front of the temple, there is a square chapel sacred to Siva or

Mahadeva. A flight of steps leads up to three narrow arched doorways, the centre one being occupied by an image of the bull *Nandi* in stone, in a sitting posture, with its back to the people, and facing the image of the god inside. The chapel is surmounted by a very picturesque dome, with stone tigers at each angle. Tall trees and thick bushes cover the hill in the rear immediately above the larger temple, and on the left there is a long native *choltry*, with a thatched roof.

The Mahabaleswar hills average an elevation of 4500 feet above the sea. They are composed almost entirely of laterite,* overlying eruptive rocks, such as basalt, greenstone, and amygdaloid; and the soil is a clay resulting from the disintegration of the laterite.

On these hills, October is the commencement of the dry season, but during that month the amount of aqueous vapour in the atmosphere is still considerable, while the temperature is cool and equable. From November the air becomes gradually drier until the end of February; the weather is dry and cold, and a sharp easterly wind usually prevails. The mean temperature of this season is 64°, with a daily variation of about 12°. Fogs and mists commence in March, and gradually increase until the rain begins in the end of May. The hottest month is April. From the end of May to September there is almost incessant rain, and the hills are constantly enveloped in clouds and fog. The mean temperature of the rainy season is

* The trap formation of the northern part of the ghâts terminates in 18° N., and is succeeded by laterite.

64°·5, but the daily variation is only 3°. The average rainfall is 227 inches, of which nearly one-third comes down in August.*

The vegetation, as might be expected from the essential difference in the climate, is quite distinct from that of the Nilgiris. There is a want of forest trees in the jungles, and the trees and bushes are, as a rule, poor and stunted. The hills are covered with grass and ferns, and are dotted over with a shrub called by the natives *rumeta*. It is the *Lasiosiphon speciosus*,† with flowers something like small Guelder roses, clustered in terminal umbels. The *Randia dumetorum*, a thorny bush, is also common. In the thickets I observed a *Memecylon*, called by the natives *anjun*, a melastomaceous tree, with beautiful purple flowers;‡ a small *Crotalaria*, with a bright yellow flower; a *Jasminum;* an *Indigofera;* the *Eugenia Jambolanum;* the pretty creeping *Clematis Wightiana;* some willows near streams; a *Solanum;* and the *Curcuma caulina*, a kind of arrowroot, with enormous leaves, sometimes tinged with red,§ in flower during the rains.‖

* *Transactions of the Medical and Physical Society of Bombay for* 1838, i. p. 92.

† Or *Gnidia eriocephala* of Graham.—Dalzell's *Bombay Flora*, p. 221.

‡ Dalzell's *Bombay Flora*, p. 93.

§ *Ibid.*, p. 275.

‖ The following list of shrubs, trees, and ferns growing at Mahabaleswar was kindly furnished by Mr. Dalzell.

LIST OF SHRUBS AND TREES GROWING ON THE HIGHEST GROUND AT MAHABALESWAR.

Eugenia Jambolanum.
Memecylon tinctorium.
Mæsa Indica.
Pygeum Zeylanicum.
Indigofera pulchella.
Actinodaphne (2 sp.).

I reluctantly formed the opinion that the Mahabaleswar hills were not suited for the growth of chinchona plants. The intense dryness of the atmosphere during the greater part of the year, the poor character of the vegetation, and even the enormous rainfall during the summer months, which more resembles the climatic conditions of the forests of Canelos to the eastward than the region of "red bark" trees to the westward of Chimborazo, all pointed to this conclusion.

But, contrary to my advice, a chinchona plantation

LIST OF SHRUBS AND TREES GROWING ON THE HIGHEST GROUND AT MAHABALESWAR—*continued.*

Bradleia lanceolaria.
Elæagnus Kologa.
Osyris Wightiana.
Lasiosiphon speciosus.
Salix tetrasperma.
Callicarpa cana.
Strobilanthus asperrimus and callosus.
Ligustrum Nilgirense.
Olea dioica and Roxburgiana.
Ilex Wightiana.
Maba nigrescens.
Diospyros (3 sp.).
Hopea spicata and racemosa.
Embella ribes and glandulifera.
Notonia grandiflora.
Artemisia parviflora and Indica.

CHINCHONACEÆ.

Grumilea vaginans.
Pavetta Indica.
Ixora nigricans and parviflora.
Canthium umbellatum.
Vangueria edulis.
Santia venulosa.
Wendlandia Notoniana.
Hymenodictyon obovatum and excelsum.
Griffithia fragrans.
Randia dumetorum.

FERNS AT MAHABALESWAR.

Lastrea densa and cochleata.
Nephrodium molle.
Sagenia hippocrepis.
Athyrium filix fœmina
Asplenium planicaule and erectum.
Diplazium esculentum.
Pteris quadrialata, lucida, and aquilina.
Campteria Rottleriana.
Adiantum lunulatum.
Cheilanthes farinosa.
Polypodium quercifolium
Pleopeltis nuda.
Pœcilopteris virens.
Leptochilus lanceolatus.
Acrostichum aureum.
Lygodium scandens.
Osmunda regalis.

was formed on the Mahabaleswar hills, a site being selected at Lingmulla on the banks of the Yenna stream, and at some distance from the crest of the ghâts, with a rainfall of 150 inches. In 1864 sixty young trees were planted, and by February 1866 they had been increased to 270 by layering. In 1874 there were 13,416 trees of *C. succirubra* and 491 of *C. officinalis*. But the climate was unfavourable, and the plants did not thrive. Consequently, in 1875, the plantation, upon which £6400 had been spent, was finally abandoned.

CHAPTER IX.

CHINCHONA CULTIVATION IN BRITISH SIKKIM.

ALTHOUGH it was necessary to select the moist zone which is entirely within the tropics, along the western ghâts, as the first and central site for chinchona cultivation; I contemplated its extension from this centre, to favourable positions in the other or Himálayan moist zone. There the resemblance to the native forests of Peruvian bark is less marked; still I hoped that the hardier kinds, especially *C. succirubra*, might flourish within the Himálayan region.

The temperate zone does not afford all chinchona requirements; but under cultivation there was reason to anticipate success at suitable elevations and at short distances from the tropic. The province of Sikkim appeared to be the most hopeful position. Situated at the base of the mighty Himálayan peak of Kanchinginga,* this region consists entirely of the basin of the river Tísta, which, with its tributaries, drains the whole country. The position of Sikkim, opposite to the opening of the Gangetic valley, between the mountains

* In 27° 41′ 26″ N. and 88° 11′ 50″ E., 27,815 feet above the sea Mount Everest is in 27° 59′ 12″ and 73 miles farther west. It is 29,002 feet above the sea.

of Bahar on the one hand, and the Khasi hills on the other, expose it to the full force of the monsoon. Its rains are therefore heavy, and are accompanied by dense fogs and a saturated atmosphere. March and April are the driest months, but rains commence in May, and continue with little intermission until October. The bounding mountains of Sikkim are very lofty, and snow-clad throughout a great part of their extent; but the central range, which separates the Tísta from its great tributary the Rangét, is depressed till very far into the interior. The rainy winds have thus free access to the heart of the province. The mean monthly temperature of the English hill station at Darjíling, which is 7430 feet above the sea, and in latitude 27° 3′ N., varies from 42° to 61° The annual rainfall is 122 inches.

No chinchona tree would flourish in such a climate as Darjíling, and in latitude 27° N. it would be necessary to seek for suitable sites in much lower situations than in the hill districts of Southern India, which are in latitudes corresponding with those of the chinchona forests. Bearing this in mind, I recommended that plants should be supplied from the Nilgiri plantations, in order to try an experiment in the Himálayas. Sikkim is covered with forests consisting of tall umbrageous trees, often with dense grass jungle, and in other places accompanied by a luxuriant undergrowth of shrubs. A comparison of the *floras* led me to the conclusion that the limit for the growth of the chinchonæ would be found where their constant companions end, the tree-ferns and *Vaccinia*, namely, at 5000 feet,

and that the best sites for *C. succirubra* would be from 1000 to 2000 feet lower, amidst the subtropical vegetation of the valleys.

In accordance with my advice, a supply of plants was furnished by Mr. McIvor to Dr. Anderson, the Superintendent of the Government gardens at Calcutta, consisting of 193 plants of *C. succirubra* and of the grey bark species.* These arrived at Calcutta in January 1862. But in opposition to my views, and to the experience derived from South America, a site was selected for a plantation in Sikkim at a height of nearly 9000 feet above the sea, near the summit of the Sinchul mountain. Thither the plants were conveyed in June 1862, and of course languished; so they were brought down to Lebong, a well-sheltered spur below Darjíling, and 6000 feet above the sea. This was in April 1863; and at the same time a second supply was sent from the Nilgiri plantations.

Finally, it was resolved to form the permanent chinchona plantation of Sikkim in the densely forest-clad and the little-known valley of the Rungbi, 12 miles from Darjíling. Ground was first broken in this valley in June 1864, at an elevation above the sea of only 4410 feet. This was in accordance with my original advice. The site is on the south-eastern slope of a long spur running out from the main ridge of Sinchul. Here 252 plants were established in the first

* Some other plants were obtained from Java; but it was never probable that any valuable species but the "red bark," the "grey bark," and the *C. Calisaya* would succeed in Sikkim.

year, 100 of *C. succirubra*, 100 of *C. officinalis*, 2 of *C. Calisaya*, and 50 of *C. micrantha*, all from the Nilgiri hills. Subsequently other patches were cleared at 5321, 5000, 3332 and 2556 feet above the sea respectively. I never entertained an expectation that the *C. officinalis* would flourish in the climate of Sikkim, and this soon became apparent. The *C. succirubra*, *C. micrantha*, and possibly the *C. Calisaya*, were the only valuable species that were likely to become flourishing natives of this extra-tropical district. The "red bark" plant thrives well there, and is propagated rapidly. In 1875 the number of *C. succirubra* trees at Rungbi was 2,390,000; and there were also 354,500 of *C. Calisaya*, 465,000 of *C. officinalis*, and 50,000 of *C. micrantha*. The number of acres under cultivation was 1939, in 1875. The rainfall is about 150 inches.

The Sikkim plantations were in charge of Dr. Anderson from 1862 to 1870. The frequent journeys from the cold of Darjíling to the hot steamy valleys of Rungbi, involving sudden and great changes of temperature, together with the effects of exposure in the feverish region of the outer Himálaya, laid the seeds of disease which caused the premature death of this able and zealous officer in the latter year. Dr. Anderson was succeeded by Mr. C. B. Clarke, and on the 10th of July, 1871, Dr. George King took charge of the Sikkim Chinchona Plantations.* Mr. Gammie was the Resident Manager.

* Dr. King is also Superintendent of the Government Gardens at Calcutta.

Dr. King has given the following description of the natural features of the Rungbi valley:—

"The Rungbi valley runs almost due west and east. At its western end it is shut in by a ridge of mountain more than 6000 feet high, in which the Rungjo stream has its origin. By its eastern extremity, which opens into the valley of the Tísta, the Rungjo stream escapes to join its waters with those of that river. Compared to its length, which is only about 16 miles, it is a wide valley, measuring from crest to crest probably little less than four miles, but contracting towards its mouth. The southern side of the valley is formed in its upper (western) half by a high range continuous with Sinchul, and not much inferior to it in height, the slopes of which above the zone of cultivation are covered with a dense virgin forest of most luxuriant growth. About half-way down the valley, at a point called Mungút, this high range curves away to the south-east, throwing out a low ridge called the Mungpu spur, which, running in an easterly direction, forms the southern side of the Rungbi valley along its lower (eastern) half. In the valley intervening between this Mungpu spur and the main ridge runs the Ryang stream. The ridge along the north of the Rungbi valley is, on the other hand, low and pretty nearly cleared of forest. Its western part is indeed occupied by the plantation of the Pomong Chinchona Association, which is separated from that of Government by the Rungjo stream. The Government plantation forms an irregular belt at the bottom of the valley and along its southern side, and has therefore a

northern exposure. This belt extends from the margin of the Rungjo stream upwards along the slopes to a height above the sea of about 3500 feet. Chinchona cultivation was first begun by Government at the western end of the valley, on the piece of ground known as Rungbi Proper, and has gradually been extended eastward, or down the valley. The eastern portion covers the ground locally known as Rishap, and, as will be subsequently explained, the extensions now being made are still eastward of Rishap.

"The climate of the Rungbi valley is peculiar. Being so completely shut in upon all sides, it is protected in a striking degree from wind, and up to the higher limits of the chinchona belt the air is rarely stirred by even the gentlest breeze, a state of things in striking contrast to that obtaining in the Nilgiris, where in exposed places great and permanent injury is done to the chinchona plants by the high winds. At the lower levels frost is completely unknown, and the climate is indeed sub-tropical; while on the higher southern and western slopes frost, and even snow, are the order of the day during the cold season. Occasionally heavy hail-storms pass over the valley, tearing to pieces the thin broad leaves of the red bark trees. The mischief thus done is, however, rapidly recovered from. The rainfall is heavy, but not equally so in all parts of the valley. The warm vapour-laden air passing up from the plains has its moisture condensed into clouds by the cool, high, forest-clad ridges that form the northern and western boundary of the valley, and

for a great part of the year the higher part of these are enveloped in drizzling fog. Even at the driest season one is struck by the amount of mist which, condensed at the higher elevations, almost every evening creeps well down their slopes, while the whole of the opposite side and of the lower part of the valley continue quite clear. During the monsoon the rainfall on these high southern ridges must be very great. Some idea of its extent may be formed from the fact that at a bungalow standing in the south-western corner of the valley, at an elevation of only 5000 feet, and thus far below the crest, the rainfall for the year averages about 200 inches. At lower levels in the valley the rainfall is very much less, and no part of the Government chinchona cultivation is exposed to such a downpour. For example, at the Rishap plantation-hut (2000 feet above the sea), where a rain gauge has been kept for some years, the average is shown to be about 120 inches, and as the mouth of the valley and the Tísta are approached, the climate becomes very much drier. The northern side of the valley, being itself comparatively low and cleared of forest, and being besides beyond the influence of the high ranges, shares in the drier climate.

"Now the greater part of the Government plantation lies under the high southern ridge just described, the drainage water of which consequently passes through it on its way to join the Rungjo. This drainage is carried off by numberless streams, most of which originate a good way up the slopes, but much of it also passes underground for a great part of its course, and

comes to the surface only a short way above the Rungjo. Moreover, on becoming superficial, a great deal of this water, scorning to be confined in channels, spreads itself over a considerable extent of ground and forms swamps. It is needless to say that in such places chinchona will not grow The most disagreeable peculiarity about these swamps, however, is that they are sometimes unexpectedly formed at places which previously appeared quite dry. This is probably due to the extreme irregularity of the surface, to the inequality of the soil and subsoil, and to the frequency of the enormous boulders, both superficial and underground, which have been rolled down the mountain-side by the action of the weather. But whatever the cause may be, the effect is, that wherever one of these swamps is formed, any chinchona that may have been planted there dies out rapidly. Farther down the valley, and below the point where the higher range bends away to the south-east and throws out the low Mungpu spur as its eastern continuation and as the southern side of the Rungbi valley, these conditions do not occur. The lower slopes there have not only a much lighter rainfall, but they have only their own drainage to get rid of, and are not required to transmit also that of a high forest-clad mountain extending several thousand feet above them. It is in these drier parts that the extension of the plantation, made during 1870, was carried on."

In 1878 the Sikkim plantations were divided into the old and the new sections. The old includes Rungbi,

Rishap, and Mungpu, covering 2000 acres, The new section is on the Sittong spur and in the Ryang valley. It includes 237,400 trees, covering 242 acres. The total number of chinchona plants in the old section is estimated at 2,904,500, namely:

C. succirubra . . .	2,454,000
C. Calisaya	354,000
C. micrantha	50,000
C. officinalis	25,000

The harvest of bark for 1878 amounted to 344,225 lbs., obtained by uprooting, coppicing, and thinning.

But the main interest in the Sikkim plantations arises from the manufacture there of a cheap chinchona febrifuge for the use of the people, to which I shall have to refer in a future chapter. In Sikkim a serious attempt has thus been made to achieve the main object I had in view in introducing chinchona cultivation into India.*

* Some other attempts have been made to extend chinchona cultivation along the northern moist zone of India. In 1867 a plantation was opened at Nunklau, on the Khasi hills. It was stocked with 600 plants of *C. succirubra* and *C. micrantha*, and several were planted out at 4585 feet above the sea. In 1869 there were 27,000 plants, which are in charge of a small native establishment.

An experiment was persevered in for several years in the Dún and the Kohistan of the N.W. Provinces, in the Dehra Dún, and at Cheguri in Garhwal, 4500 above the sea. But all chinchona trees are destroyed, when planted out in these districts, by the frost during the cold season.

Colonel Nassau Lees also made a very extended trial in the Kangra valley. His plantation, called New Quito, was in 30° 7′ north latitude, and 4500 feet above the sea.

For some time the prospects of success appeared hopeful. In May 1864 Colonel N. Lees had 403 plants at New Quito, and in July 857. In March 1865 there were 4297. But ultimately the plants suc-

In 1876 "A Manual of Chinchona Cultivation in India" was published by Dr. King, which contains a brief history of the enterprise, and details respecting the management of plantations, which will be most useful to all who undertake to cultivate Peruvian bark trees.*

cumbed to frost. The attempt was referred to, with commendation, by Sir Charles Wood, in his despatch to the Government of India, dated August 8th, 1864. The experiment, which was conducted with skill and care, was most creditable in every respect, and deserved success.

* *A Manual of Chinchona Cultivation in India*, by George King, M.B., F.L.S., Superintendent of the Royal Botanical Gardens at Calcutta and of Chinchona cultivation in Bengal. (Calcutta, 1876. Folio, pp. 80.)

CHAPTER X.

CHINCHONA CULTIVATION IN BRITISH BURMA.

THE higher parts of British Burma, being within the moist belt and also within the tropics, offered hopeful situations for the growth of Peruvian bark trees. In 1865 a few plants were established on the top of the Bogalay hills, east of Tounghoo. In December 1868 a supply of 188 plants of *C. succirubra* was planted out at Phunado, at an elevation of 2100 feet; and of these 147 survived in March 1870. Captain Seaton, the Conservator of Forests in British Burma, took great interest in the experiment, and in August 1868 he brought two Karen lads with him to Utakamand, that they might receive instruction under Mr. McIvor. They returned to Rangoon in November 1869, after having gone through a course of training. But unfortunately one of these lads died in 1870.

In the year 1870 Phunado was in great part abandoned, and a site was selected as the head-quarters of chinchona cultivation in British Burma, called Thandoungyee. It is 18 miles N.E. of Tounghoo, the hills being from 3700 to 4400 feet above the sea. In 1871 the cuttings raised at Phunado were brought to the new site, and 500 plants were established in the main

plantation. The surviving trained lad, named Tokai, was placed in charge, under Dr. Adamson of the Sittang Division, and a large number of seedlings were raised in nursery-beds and in the propagating-house during 1872. In 1873 an area of 9 acres was felled, and planted with 6000 seedlings and cuttings. To this 27 acres were added in the following year, and in 1875 a still more extensive clearing was made. In October 1875 there were 44,000 chinchona trees in the Thandoungyee Plantation. The *C. succirubra* succeeds best in these Karen hills, and 50 acres are now planted with it. The soil is a light red humus formed by the decomposition of granitic rock, and it has a great preponderance of coarse quartz sand. The rainy season lasts from May to October, and the range of the thermometer is from 43° to 84°.

The Karens have undertaken the cultivation under the auspices of the missionaries, and 3000 seedlings have been distributed to them. The plants certainly thrive, but it is feared that they may never attain the size of full-grown trees, always remaining stunted and branched like the surrounding evergreen vegetation.

Their total yield of febrifuge alkaloids is, however, satisfactory, being 4 per cent. in 1873; and the trees will be valuable in supplying the febrifuge for local use. It was intended to train Karen lads in planting and cultivating chinchona trees, with a view to introducing the plants among the Karen and other hill tribes of British Burma. Seedlings will be reared, in considerable quantities, for gratuitous distribution.

CHAPTER XI.

CEYLON.

THE hill districts of the island of Ceylon, which have the necessary elevation and are within the region of both monsoons, offered peculiarly favourable conditions for the cultivation of Peruvian bark trees. I always looked upon its introduction into Ceylon as a measure only second in importance to the naturalisation of the trees in British India; and my view was confirmed by the strongly expressed opinion of Sir William Hooker. That distinguished botanist was even inclined to consider the hills of Ceylon as more suitable for chinchona cultivation than any part of India. Mr. Thwaites, the Director of the Royal Botanical Gardens at Pérádeniya, near Kandy, also took a deep interest in the undertaking, and under his able superintendence I was confident that success would be secured.

The gardens at Pérádeniya are only 1594 feet above the level of the sea, and far too low and hot for successful chinchona cultivation; but there are many other localities in Ceylon admirably suited, from their elevation and climate, for the growth of the trees, from 5000 to 8000 feet above the sea. Among them was the Government garden of Hak-gala near Nuwara Eliya,

which is 6210 feet above the sea, in a climate with a mean temperature of about 59°, and abundantly supplied with moisture. Here most of the chinchona plants were established, on their arrival in Ceylon, under the superintendence of Mr. Thwaites, who was assisted in their cultivation by Mr. McNicoll, a zealous and intelligent gardener from Kew.

In February 1861 the first instalment of chinchona seeds arrived in Ceylon, being a parcel of the "grey bark" species sent from the Nilgiri hills by Mr. McIvor. Soon afterwards a share of the seeds of *C. succirubra* was received. By September 800 plants had been raised from these seeds. In January 1862 I forwarded parcels of seeds of *C. officinalis* to Mr. Thwaites, and early in March six Wardian cases filled with chinchona plants arrived from the depôt at Kew. The cultivation was thus fairly started. Hak-gala was treated as a nursery and as a centre of distribution, whence the coffee planters, who readily entered upon the cultivation, were supplied with young trees. Up to 1864 Mr. Thwaites received applications from eighteen planters, for an aggregate of 28,524 plants.

In November 1865 I inspected the chinchona plantation at Hak-gala, and a large coffee estate called Rothschild, 3200 feet above the sea, where several acres had been planted with chinchona trees. At that time 500,000 plants had been applied for, and as many as 180,000 had been distributed. It was clear that there was a serious intention among the planters to make Peruvian bark one of the staple products of Ceylon.

The knot of mountains, in the central province of Ceylon, which at one point attains a height of 8280 feet above the sea, is entirely composed of gneiss with veins of quartz. The soil formed by the disintegration of this rock is not rich, but the poverty of soil is made up for by sufficient supplies of moisture and a genial climate. Though the valleys formed by the mountain spurs are extensively cleared and planted with coffee, there is still a good deal of forest at higher elevations, and one of the loftiest plateaux is the hill station of Nuwara Eliya, 6220 feet above the sea. From Kandy the way passes through Gampola and Pusilawa, and then winds up the northern face of the mountains by an excellent road. As Nuwara Eliya is approached, the *flora* resembles closely that of the hills of Southern India. The woods are composed of *Michelia, Symplocos, Gaultheria, Vaccinium,* myrtles, with an undergrowth of *Lobelia excelsa,* balsams, *Osbeckia, Sonerila, Solanum Indicum,* a passion-flower and madder. Beautiful tree-ferns grow in the shade, and the *Rhododendron arboreum* is scattered over the open grass land. The *patenás,* or smooth grassy glades, alternate with the forest-covered land, on the sides of the mountains. The station of Neuera-ellia,* consisting of bungalows nestling among Australian gum-trees, is on a plain bounded, on the east and west, by tree-covered hills, crested here and there by bare ridges of gneiss. The masses of cryptogams on the branches and stems indicated the dampness of the climate.

* This station was formed in 1829 by Sir Edward Barnes.

The chinchona plantation of Hak-gala, six miles south of Nuwara Eliya, is 5200 feet above the level of the sea. The position was admirably chosen. Hak-gala is a magnificent perpendicular cliff, rising out of a fine forest which clothes the steep slopes of the mountain. The site faces the north-east. It is protected from the full force of the south-west monsoon by the cliff, while it receives a good supply of rain during both seasons. No place in the East so vividly reminded me of the chinchona *pajonales* of Peru as the view from the Hak-gala plantation. A mountain torrent dashes through the wide ravine, and the hills on either side are clothed with alternate forest and grass land, while to the south are the distant hills and valleys of the Uvah district. These open grass lands, called *patenás* in Ceylon, are precisely analogous to the *pajonales* of Peru. They are of frequent occurrence in the Ceylon hills, being covered with coarse tufts of lemon-grass (*Andropogon schœnanthus*), but no trees grow on them, and they are considered unsuitable for coffee cultivation. On the day of my visit to Hak-gala there were showers from the south-west in the forenoon, and in the afternoon a dense mist rolled up from the Uvah valley, and enveloped the plantation. This is exactly the course of atmospheric daily change in the uplands of Caravaya, and as I watched the white mist wrapping tree after tree in its thick folds, I almost fancied myself once more standing on a chinchona *pajonal* in Peru.

Some ten acres had been cleared under the grand old

Hak-gala cliff. The plants were completely in the open, and looked healthy and vigorous. The total number of plants and cuttings was, in 1865, about 500,000. The result of the analysis of Ceylon bark made by Mr. Howard in 1866, was that the *C. officinalis* was the best species for cultivation in that island. The bark yielded nearly four per cent. of quinine, and seven per cent. of total alkaloids.

The great coffee planting interest in Ceylon ensured a thorough and complete trial for chinchona cultivation in the island, so far as the commercial profit to be derived from it was concerned. Through the initiative of Sir Edward Barnes, who was Governor in 1826, coffee planting in Ceylon was undertaken with energy, and soon the mountain ranges round Kandy were covered with plantations, as well as the great valleys of Doombera, Ambogammoa, Kotmalie, and Pusilawa, the slopes leading to Nuwara Eliya, and the districts of Badulla and Uvah to the south. Twenty years ago there were 404 estates with 63,771 planted acres in bearing, besides 17,179 planted but not yet bearing. The produce was 347,100 cwts. of coffee; exclusive of the coffee grown by the natives round their villages. Altogether not less than 130,000 acres were yielding coffee in 1857. Since that year Ceylon has continued to prosper. In 1877 there were 1357 coffee estates with 272,243 acres under cultivation, the average crop being 727,420 cwts. On these estates 300,000 labourers are employed. The numerous enterprising and intelligent planters were sure not to overlook a great

source of profit, placed conveniently within their reach, such as was offered by the chinchona nursery at Hak-gala.

Since the period of my visit in 1866, hundreds of thousands of seedlings and many ounces of seeds have been distributed to the planters of Ceylon from the Hak-gala plantation; and chinchona cultivation has become a very important and lucrative adjunct to coffee planting. In 1873, 670,500 plants were distributed from Hak-gala, 826,000 in 1874, 794,500 in 1875, 1,196,000 in 1876, 1,250,000 in 1877; total, 5,500,000.* The number of acres under chinchona cultivation in Ceylon was 5578 in 1877. Mr. J. L. Macmillan† says that the total number of trees planted out must now be close on 7,000,000. He adds:—

"The entire cultivation is carried on by private companies and private proprietors; Government so far having only given its attention to the propagation, nursing, and classification of the plants.

"Succirubra is the variety in favour, the variety in demand, the variety that pays, and the variety that thrives, it requiring little attention in propagation, and costing next to nothing to rear. It may be found growing luxuriantly everywhere, in the mountain provinces, on fertile estates, and on the poorest patená soils, around Government rest-houses and remote police stations, in the various Kacheri grounds and gardens of Government

* Plants were distributed gratis at first, but since 1872 a charge of ten shillings per 1000 plants has been made.

† Paper read at the Pharmaceutical Society, April 20th, 1878.

residences; from the ancient kingdom of Kandy to the confines of the principality of Uvah. So familiar indeed has it become to the eye of both colonist and native, that it is looked upon as indigenous; the latter having now the fullest confidence in it as a remedy, and not hesitating to help himself to a strip of bark from the nearest tree when occasion necessitates it."

The species which form the bulk of the plantations are *C. officinalis* and *C. succirubra*, as in India. The area over which suitable sites can be found is extensive. The following is a description of the climate of one such locality in the Dimbula district:—

"There is a mean temperature of 65°·8 Fahr., with nothing colder in the shade in winter than 44°·5 (12° above freezing-point), and nothing hotter in the shade in summer than 89°, both extremes being exceptional, and the latter helping to produce a maximum temperature favourable to coffee cultivation, equally so to tea and chinchona, without being injurious to human health. Dismissing the rarely occurring extremes, we get a mean maximum in the shade of 73°·2 Fahr. against a mean minimum of 58°·4 Fahr., resulting, as we have already noticed, in a mean shade temperature of 65°·8 Fahr. On a clear January morning, before the sun has dawned, the exposed thermometer may indicate a cold of 33° Fahr., or only one degree above freezing-point; while at noon-day in April (our hottest month) the mercury may, under the full influence of the sun's rays, rise to 136° Fahr. But these, again, are the extremes on the grass and in the sun; the mean maximum of

the exposed thermometer being only 103°·5 Fahr. against a mean minimum of 54°·1 Fahr."

Thus the introduction of chinchona cultivation into Ceylon has been attended with complete success, and a most valuable addition has been made to the staple products of the island. The results, as regards commercial profit, will be referred to presently in the chapter on the Bark Trade.

CHAPTER XII.

CHINCHONA CULTIVATION IN JAVA, JAMAICA AND MEXICO.

JAVA.*

THE Java chinchona plantations remained under the superintendence of Dr. Junghuhn until his death in April 1864, and during this first period two great mistakes were made. The species called *C. Pahudiana*, which is worthless as regards its yield of the febrifuge, was extensively propagated, and an erroneous system of cultivation was adopted. The trees were planted out in the forests, under dense shade.

The second period commenced with the appointment of Mr. H. van Gorkum to the charge of the plantations. In 1862 a supply of plants of valuable species had been received from the Nilgiri Hills, namely, *C. succirubra* and *C. micrantha*, and in 1865 plants and seeds of *C. officinalis* were presented to the Java plantations. Thus useful kinds began to be propagated, and in 1868 there were 354,797 chinchona trees planted out, without counting the worthless *C. Pahudiana*. The plantations are chiefly on the mountains in the Preanger division of Western Java, from 4400 to 5000 feet above the sea. Mr. van Gorkum was succeeded, in the conduct of the

* See pages 77 to 83 for the early history of the Java Plantations.

enterprise, by Mr. J. C. Bernelot Moens, who is still in charge of the Java chinchona plantations. He is an accomplished chemist.

In 1866 the Dutch Government bought a portion of the remittance of *C. Calisaya* seeds from Mr. Ledger's brother, which had been collected in the Bolivian forests by Manuel Incra Mamani. These seeds were at once sent out to Java, and sown in the nurseries by Mr. van Gorkum, who raised 20,000 plants. Small lots of Java bark had been brought into public auction at Amsterdam in 1870 and 1871, but it was not until March 1872 that any large quantity of that bark was offered for sale. The sale of March 14th, 1872, consisted of 5800 kilogrammes collected from all the five species growing in the Java plantations.

When the plants from Mr. Ledger's seeds came to maturity it was found that their bark was extraordinarily rich in quinine, and that the trees throve well in the mountains of Java, although the climate of the Nilgiri Hills does not appear to suit them. An analysis of several specimens of the bark grown in Java, gave a yield of 9 per cent. of quinine and 10½ of total alkaloids in one instance, of 9·9 per cent. of quinine, and 11·9 of total alkaloids in another. The yield of quinine was so extraordinary that the tree was looked upon as forming a distinct variety, and it has been named *C. Calisaya*, var. *Ledgeriana*. Since this discovery the attention of Mr. Moens has been chiefly directed to the propagation of the rich variety of *C. Calisaya*, which will now be cultivated, almost to the exclusion of all others, in the

Java plantations. At the end of 1879 the number of valuable chinchona trees planted out (exclusive of *C. Pahudiana*) was as follows:—

I.	*C. Calisaya* (var. *Ledgeriana*) . . .	355,070
	„ (var. brought by Hasskarl) . .	698,000
II.	*C. officinalis* (from the Nilgiri hills) . .	377,000
III.	*C. succirubra* („ „) . .	219,700
IV.	*C. micrantha* („ „) . .	260
V.	*C. lancifolia* (from a plant sent by Dr. Karsten)	28,640
		1,678,670

Some of the trees of *Ledgeriana* had seeded, but the harvest of seeds was very small. The harvest of bark, in 1879, is reported to have amounted to 106,000 lbs. (*Amst.*). Of this, 70,088 lbs. were sold in the market in Holland, 2181 lbs. were kept for use in Java, and 33,731 lbs. remained in store.

JAMAICA.

The Blue Mountains of Jamaica presented a probable site for successful chinchona cultivation, being about the same distance from the equator on the north side (18° N.) as the Calisaya forests are to the south, and attaining a height of 7150 feet. The principal ridge, running east and west, averages an elevation of from 5000 to 6000 feet. It was decided, from the first, that a portion of the seeds collected in South America should be entrusted to the care of Mr. Nathaniel Wilson, the Superintendent of the Government Gardens at Jamaica; and he received a supply of seeds of *C. succirubra, C. nitida,* and *C. micrantha,* in November 1860. He selected a site for their cultivation on

Mount Essex, a spur of the Blue Mountains, four miles north of Bath, and 2500 to 3000 feet above the sea. Here 300 plants were raised, and in 1862 three acres had been cleared. On the 16th of November, 1861, some chinchona trees were planted out at a place called Cold Spring, near Newcastle Garrison, and 3600 feet above the sea. These trees are now nineteen years of age, and are the oldest trees in Jamaica. One of them is 42 feet high, with a trunk 40 inches in girth, and would yield 16 lbs. of Peruvian bark.

In 1868 Mr. Robert Thomson had succeeded Mr. Wilson as Superintendent. He acquired, for the Government, a run of virgin soil of 600 acres, on the south slope of the Blue Mountains, 4000 to 6000 feet above the sea, and 24 miles from Kingstown. The annual rainfall varies from 88 to 108 inches, the soil is excellent and several streams flow through the run. Possession was obtained in May 1864, fifty acres were ready in August, and 20,000 trees were planted out. A glass propagating-house and other necessary buildings were erected; and a further supply of seeds was received from Ceylon, through Sir J. Hooker, consisting of *C. officinalis* and *C. Calisaya*. Thus the experiment took a new departure from 1868, under Mr. Thomson's auspices.

In 1872 the first analysis of bark was made by Mr. Howard,* with very satisfactory results, as regards the *C. succirubra* and *C. Calisaya* species, and an equally hopeful report by Dr. De Vrij resulted from his

* See *Pharmaceutical Journal*, iii. p. 83, 1873.

analysis of bark in 1873.* The *C. officinalis* does not thrive so well in Jamaica, and assumes a shrubby form. The average height of the *C. succirubra* and *C. micrantha* trees, after ten years, is from 15 to 27 feet, of *C. Calisaya* from 12 to 20 feet, and of *C. officinalis* only from 8 to 12 feet. The tallest *C. succirubra* is 3 feet 5 inches, with a circumference of 26 inches; and the tallest *C. Calisaya* is 25 feet high. The hurricane of November 1st, 1874, seriously injured 60,000 trees, and at first there was great mortality among the seedlings. But the latter difficulty has been overcome by fitting the propagating-house with hot-water apparatus.

In 1878 Mr. G. S. Jenman succeeded Mr. Thomson as Superintendent. Mr. Jenman reported that, in 1878, there were 450 acres planted out with 120,000 chinchona trees, of which 50,000 were *C. succirubra*, 50,000 were *C. officinalis*, and 20,000 were *C. Calisaya*. The annual cost of the plantation was £1567. Bark from Jamaica has already appeared in the London market. In January 1878 three bales of Jamaica red bark were sold at 1*s.* to 2*s.* 3*d.* the lb. In September of the same year four bales fetched 2*s.* 10*d.* per lb., and in July 1879 six bales were sold, fetching 4*s.* per lb. Much larger quantities arrived in 1880, namely, 100 bales † in February, 122 bales in May, and in August the Jamaica plantations sent 81 bales of bark to the London market, which were all sold, some of the bark fetching as much as 8*s.* 10*d.* per lb.

* See *Pharmaceutical Journal*, August 16, 1873.

† The Jamaica bales contain from 60 to 80 lbs. of bark.

Chinchona cultivation is now successfully established in the Blue Mountains of Jamaica.

MEXICO.

Humboldt remarked that, although there were parts of Mexico well suited for the growth of chinchona trees, none were to be found there. He specially remarked that they might be expected to be found in the beautiful Mexican woods of Jalapa, whither the soil, and the climate, and their usual companions, the tree-ferns and Melastomaceæ, seem to invite them.*

I conceived the idea of fulfilling this expectation of Humboldt, and of supplying Mexico with the fever-dispelling tree, from our Indian plantations. The suggestion was made by me to my old friend Captain Maury, then in the Mexican service, and was warmly taken up by the Emperor Maximilian. I received an official letter expressing the Emperor's anxiety to inaugurate such an experiment, in October 1865, and immediately took the necessary steps. In June 1866 a supply of chinchona seeds, consisting of 120,000 of *C. succirubra*, 90,000 of *C. Calisaya*, and 25,000 of *C. officinalis*, was transmitted from the Nilgiri Hills to England, and immediately forwarded to Mexico.

The mountainous and forest-covered belt of Mexico, which intervenes between the "Tierra Caliente" of the coast and the interior table-land, is the same distance from the equator to the north, as part of the chinchona region of Peru and Bolivia is to the south; while there

* *Essai sur la Géographie des Plantes* (Paris, 1807).

are positions with similar climate and elevation above the sea. In this belt a site for chinchona cultivation was selected near Cordova, and the enterprise was entrusted to the care of Señor Nieto. He received the chinchona seeds at Cordova, on the 14th of October 1866, and at once sowed the greater part of them in wooden boxes filled with good soil, and protected by glass and light movable curtains. The rest were distributed to intelligent proprietors.* A large proportion of *C. succirubra* and *C. Calisaya* seeds germinated, and the plants were distributed among the neighbouring proprietors of estates who were capable of understanding the great importance of chinchona cultivation.

Cordova is 2800 feet above the sea; and there are many sites still more favourable for the growth of these trees along the whole length of the Mexican range.

Having received encouraging reports of the growth of the chinchona trees in Mexico from Señor Nieto, I arranged that he should be furnished with a second supply of seeds. In November 1871 I received from the Nilgiri Hills, four ounces of seeds of *C. succirubra* and four ounces of *C. officinalis,* and immediately forwarded them to Señor Nieto. They arrived at Cordova on April 25th, 1872; and the energetic cultivator at once proceeded to sow a portion, and to

* Mr. Finch of the Hacienda Potrero, Don F. M. Sanchez Barcena of Jalapa, Mr. Grandison of Orizaba, and Don Carlos Sartorius of the Hacienda Mirada.

distribute the rest. He succeeded in establishing a plantation of healthy chinchona trees above Cordova, and there was every promise of the ultimate success for the experiment. I supplied Señor Nieto, and other Mexican cultivators, with copies of my "Manual of Chinchona Cultivation" in Spanish.

But the infamous murder of the good and enlightened Emperor Maximilian in June 1867 was a sad blow to the progress of chinchona cultivation, and to many other useful measures which his Majesty had initiated for the benefit of Mexico; and from that time there was nothing but discouragement and obstruction. Señor Don J. A. Nieto worked on quietly and unostentatiously until his lamented death in 1874. I have not since received any news from Cordova. But the trees were already well-grown, and samples of bark and sections of stems of chinchona trees from Mexico were exhibited in the International Exhibition of Philadelphia in 1876. I trust, therefore, that the great and beneficent measure has succeeded, and that the cultivation of chinchona trees is now established in Mexico. It will be one permanent memorial of the rule of the ill-fated Emperor Maximilian.

CHAPTER XIII.

SUPPLY OF THE FEBRIFUGE TO THE PEOPLE OF INDIA. PROCEEDINGS AT THE NILGIRI PLANTATIONS.

IT cannot be too often repeated that the object of the introduction of chinchona cultivation into India was the provision of an abundant and cheap supply of the febrifuge, so as to bring the remedy within the reach of all classes of the people. The object was not to produce the best barks for the European markets, nor to ensure commercial profit, nor to increase the revenue, nor to benefit the planting interest. These are all highly satisfactory collateral results, but they are not, and never should be, considered as the objects of the undertaking.*

In the arrangements for analysing the bark, in the appointment of a resident chemist, in the experimental manufacture, in the investigations to ascertain the comparative value of different alkaloids, the main object was kept in view.

The analysis of East Indian barks was commenced

* My object in introducing chinchona cultivation into India was recognised as the true object, and my views were adopted by successive Secretaries of State for India. See the despatches of Sir Charles Wood, dated January 16th, 1863 (par. 4) and September 30th, 1865 (par. 5); of Lord Ripon, dated 16th June, 1866 (par. 4); and of the Duke of Argyll, dated April 4th, 1871 (par. 3) and December 16th, 1873 (par. 4). All are published in the Chinchona Blue Books.

by Mr. Howard in 1863; and a second analysis was made later in the same year. The bark was eighteen months old, and it yielded eight per cent. of alkaloids. In November 1863 Dr. De Vrij analysed bark of *C. succirubra*, grown at Nedivattam, from which he obtained the hitherto unprecedented yield of 8·4 per cent. of alkaloids. The third analysis, by Mr. Howard in 1864, and the fourth in 1865, continued to give most encouraging results. The analysis of 1865 established the fact that cultivation was improving the yield of alkaloids in the *C. succirubra* species. Some of the bark of this year, being three and a half years old, was sent to Dr. De Vrij, who obtained 11 per cent. of febrifuge alkaloids from it, and pronounced it to be the most valuable specimen of bark he had ever manipulated. The conclusions arrived at were that the yield, under cultivation, increases two and threefold even during the first three years of growth; that the application of damp moss tends to thicken the bark; that strips may be taken from the stem without injuring the tree; and that the renewed bark is richer in alkaloids than the first growth. It was becoming evident also, that the bark for India would be the *C. succirubra*, because, while yielding the largest quantity of febrifuge alkaloids, it is also the most hardy, the most easily propagated, and the best adapted to the climates of the Indian hill districts. It can, therefore, be cultivated over a larger area than any other kind; and the wide extension of the cultivation is a chief means of ensuring our object.

The examinations of the bark had shown that the yield of total alkaloids was very large, but that chinchonidine and quinidine predominated over quinine, and even that future increase in the yield would probably be in the direction of other alkaloids rather than in that of quinine. At that time quinine was vulgarly believed to be the real febrifuge, or at least that its febrifuge virtues were far superior to those of any of the kindred alkaloids derived from chinchona bark.

It became, therefore, a matter of the greatest importance to ascertain the relative value of the four chinchona alkaloids, namely, quinine, chinchonidine, quinidine, and chinchonine.* Mr. Howard represented this necessity as a consequence of the results of his analyses, and, as soon as I returned from India in 1866, I proposed that medical commissions should be appointed in the three Presidencies, to try experiments with the four alkaloids on such a scale as that their final decisions might be conclusive, and to report the results of their investigations. I had also made similar representations to the Madras Government.† My proposals were adopted, and carefully prepared supplies of the four alkaloids were sent out to India for the trial.

The Madras Commission consisted of officers who had all had long experience in the treatment of fevers. The course they adopted was to select medical men in whose reports implicit reliance could be placed, and whose charges were in feverish districts; and to supply

* See page 33.

† In letters dated January 16th and February 7th, 1866.

them with sufficient quantities of all four alkaloids, to enable them to give the medicines a full trial. Up to February 1867 the number of cases of fever treated was 1145, of which 410 were treated with chinchonine, 359 with chinchonidine, and 376 with quinidine. The results were satisfactory, and the conclusion of the Commission was that the other alkaloids are scarcely, if at all, inferior to quinine as therapeutic agents. In a second report, dated April 1868, the Commission was able to speak with still larger experience, for 2472 cases of fever had been treated, all being fevers of true paroxysmal character, caused by malaria. This time 846 cases were treated with quinine, 664 with quinidine, 403 with chinchonidine, and 559 with chinchonine. There were 2445 cures. Quinidine and chinchonidine were found to be quite equal to quinine in every respect. With quinine there were 5 failures, with chinchonidine 3, with quinidine 3, and with chinchonine 13. The final conclusion was that quinidine is quite equal to quinine, that chinchonidine is only slightly less efficacious, and that chinchonine, though inferior to the others, is also a valuable remedial agent in fever.

Similar Medical Commissions were appointed at Calcutta and at Bombay, and all virtually came to the same conclusions. It was thus the unanimous opinion of the highest medical authorities in all the three Presidencies, after most complete trials, that quinidine and chinchonidine were equal to quinine, and that chinchonine was only slightly inferior, merely requiring somewhat larger doses to complete the cures.

Mr. Howard's opinion,—and there is no higher authority,—is that chinchonidine is in no sense inferior to quinine, but somewhat different in its operation, and in some cases to be preferred. Quinidine is equal to chinchonidine; and chinchonine, Mr. Howard believes, is as powerful as quinine. He uses it for gratuitous administration, and never fails to arrest intermittent fever with it. He uses the muriate of chinchonine, his reasons being cheapness and facility of administration.

The Medical Commissions conclusively decided a very momentous question. It is now known that all the chinchona alkaloids have febrifuge virtues, and that consequently it is not the yield of quinine that is to be specially sought after for our object, but the largest yield of total alkaloids in the species which can be most extensively cultivated. This established, the *C. succirubra* is the species for the people of India; while the *C. officinalis* and *C. Calisaya* furnish the best barks for European markets, and for making the enterprise a complete financial success.

The great question had yet to be settled. The trees were flourishing, harvests of bark were gathered, but it remained to decide how the febrifuge could be brought, in its cheapest and yet most efficacious form, within reach of the poorest people in the land. Eventually, and in the fulness of time, the febrifuge will undoubtedly be manufactured and supplied on the spot, in some form. Long before quinine was discovered, decoctions of bark had cured thousands of sufferers from fever, and this simple form of the febrifuge is destined, I trust, to

prove a blessing to many a fever-haunted district of India. Its manufacture is so simple that it may be carried on by every family that has a few trees planted at its door. It is merely necessary to pound the bark up until it will pass through a rather fine sieve, mix in the proportion of about ten ounces of bark to one gallon of water, boil, and strain off. A decoction of bark is said to be often more efficacious than quinine; and results are to be obtained from it which are not to be derived from the pure alkaloids.*

It is desirable, however, that the alkaloids themselves, extracted from the other ingredients of the bark, should be brought within the means of the poorest native family. I tried an experiment with the aid of Mr. McIvor, when I was at Utakamand in 1866; and manufactured a preparation which required only slaked lime and alcohol. It was called *quinium* † and retained the febrifuge alkaloids, while the greater part of the other component parts of the bark, which have little or no febrifuge qualities, was eliminated. This experiment showed me that the ingredients required for manufacture could be economically obtained in India, and led me to infer that a cheap febrifuge might be supplied on the spot.

For the determination of this question, and for the study of the various problems connected with the formation of alkaloids in the bark of living trees, I

* *Pharmaceutical Journal.* Discussion on Mr. Howard's paper read 15th September, 1877, p. 210.

† Called, in French works on pharmacy, "*Extrait alcoolique de quinquina à la chaux.*"

considered it necessary that there should be a quinologist residing on the Nilgiri Hills, who could carry on his investigations and analyse the barks on the spot. My recommendation was adopted, and Mr. John Broughton, an accomplished analytical chemist, who had been Dr. Frankland's assistant at the Royal Institution, was appointed Quinologist to the Nilgiri Chinchona Plantations on September 22nd, 1866.

The instructions which I drew up for Mr. Broughton's guidance directed his attention to two main objects, the investigation of the causes which regulate the yield of alkaloids, and the discovery of the preparation which would combine cheapness with efficacy in the highest degree. I pointed out to him that the analysis of bark from trees growing in various situations, would be a principal means of discovering the conditions, as regards elevation, climate, soil, and exposure, best calculated to produce the largest yield of alkaloids. I also assigned to him the duties of ascertaining the difference, as regards yield and efficacy, between green and dry barks, the best methods of harvesting and drying, and of preparing a cheap febrifuge medicine. Finally, I impressed upon him the great importance of acting in concert with the Superintendent of Cultivation. Mr. Broughton arrived at Utakamand in January 1867, and submitted a preliminary report in the following April.

In 1869 Mr. Broughton found the yield of total alkaloids in *C. succirubra* to be 7·4 per cent., and in 1871 it was 7·8. His conclusion was that this species

attained its greatest yield in the eighth year. The *C. officinalis* bark yielded 6·9 per cent. of total alkaloids in 1869, and 8·3 in 1873, more than half of which was quinine. Mr. Broughton made very useful experiments in drying the bark, a point of great importance and requiring chemical knowledge for its correct solution. He also studied the questions of the best season for harvesting, of the effects of manuring, of hybridising, and of the form in which alkaloids occur in the living bark. These investigations were exceedingly valuable.* Their results fully justified the appointment of Mr. Broughton, and showed the necessity for having a resident analytical chemist at the plantations.

In 1870 Mr. Broughton commenced the preparation of a cheap febrifuge at a factory on the Nedivattam plantation, which he called "amorphous quinine." The ingredients required for its manufacture were sulphuric acid, lime, caustic soda, and alcohol; and the resulting medicine was in the form of a yellowish-brown powder. The intention was to turn out 800 lbs. of the febrifuge annually. It was calculated that the cost of producing a pound of bark was from 4*d.* to 6*d.*, that there would be a 4 per cent. yield, and that the cost of 1 lb. of the alkaloid, including interest on the plant, would be Rs. 16, or 1 rupee per ounce. So far as the manufacture was allowed to proceed, the results were satisfactory in every respect. The factory produced 21½ lbs. of the febrifuge in 1870, 127 lbs. in 1871, 100 lbs. in 1872, and 345 lbs. in 1873. There was also a progressive

* See Appendix, *Bibliography.*

improvement in the yield of alkaloids, which was 0·12 per cent. of the green bark in 1870, 0·24 per cent. in 1871, 0·28 per cent. in 1872, and 0·43 per cent. in 1873.

Mr. Broughton's preparation was perfectly efficacious. It was used in the feverish districts of Wainad and the Upper Godavari, and out of 1882 cases treated with it, 1878 were cured. The Surgeon-General of Hospitals reported, on April 28th, 1874, that the "amorphous quinine" was a sure febrifuge, and that, if it could be sold at 1 rupee per ounce, it was extremely desirable that it should be manufactured in large quantities.*

No correct judgment could be formed of the financial result until the factory was in full work, and turning out 800 pounds annually, or more. The ingredients, except acid and caustic soda, were obtained in the country, and their cost was small in comparison to the work done. But the outlay, as regards labour and many other items, is the same whether the out-turn is large or small, so that no reliable calculation could be made as to the real cost, until the factory was working up to its full power. Moreover, experience would have suggested improvements in the arrangements for pressing the bark, for preventing loss of alkaloids, and other details. Unfortunately this hopeful experiment, so fraught with benefit to the people of the Madras Presidency, was cut short prematurely, and before a fair trial had been made.

A Committee was appointed by the Madras Govern-

* Letter from Surgeon-General Balfour, dated 28th April, 1874 (No. 189).

ment to report upon the financial result of the manufacture before any correct conclusion could be formed. In their Report, dated November 28th, 1874, they submitted a calculation by which it was made to appear that the "amorphous quinine" was produced at a loss. In the years 1872 and 1873, the quantity produced was 445 pounds. By arbitrarily charging the factory with £2500 for the bark, and £583 for the cost of working, and interest on plant and buildings, they made out that the 445 lbs. cost £3083, and they placed its value at £1500. By these figures they made out a loss of £1583. Their calculations are misleading. It was quite premature to attempt any calculations at so early a stage. The legitimate profit from the sale of bark to pay off the capital charge would, in a few years, have secured a net result obviating all pretext for charging anything for the value of the bark against the factory, while the actual charges would have been lowered by improved arrangements, the results of experience. The capital charge, with interest, has now actually been paid off, and the only legitimate charge against a factory is, therefore, the cost of cultivating the bark. The cost to the Government of producing one pound of bark, as proved by experience in Sikkim, ought not to be more than 5*d.*; and the factory would, as soon as it was in full work, have turned out one pound of the febrifuge at a cost of six shillings, as in Sikkim. So that the febrifuge could have been sold, at a profit, for less than 1 rupee per ounce. But the whole system of manufacture would eventually have

become more economical in proportion to the increased production; and Mr. Broughton had certainly made a most promising beginning of a useful work.

The Committee's Report had a most disastrous effect. Mr. Broughton resigned his appointment, and left India in December 1874. His place has not been filled up. All attempts at producing a cheap febrifuge for the use of the people were at once put a stop to. The great objects of the enterprise were abandoned. The Nilgiri plantations have, especially since Mr. McIvor's death, been sadly mismanaged. The only object has been to obtain harvests of bark to sell at a profit in the London market, without regard to the renewal of gaps, and to keeping the plantations up to a proper standard. There has been undue destruction of valuable trees. I have reason to fear that there has been miserable waste and havoc, to secure large present results, without regard for the future.

Yet the trees remain, though in diminished numbers, and flourish. The work can be taken up where it was unwisely dropped, at any time, when a future Government is better advised. The good work cannot be altogether undone. A scientific superintendent of the plantations, combining chemical knowledge, like Mr. Moens in Java, is urgently needed. There have been checks and disheartening delays. But the plantations are still safe. Sooner or later the broken continuity will be restored, work in the right direction will be resumed, and the great object of the enterprise will be finally secured here, as elsewhere.

Meanwhile the whole interest of the experimental manufacture centres in the Sikkim plantations, where more enlightened views have prevailed during recent years, and where the true object of chinchona cultivation is understood and appreciated.

CHAPTER XIV.

SUPPLY OF THE FEBRIFUGE TO THE PEOPLE OF INDIA. PROCEEDINGS AT THE SIKKIM PLANTATIONS.

THE importance of supplying the people of India with a cheap febrifuge has been fully realised by those who have had control of the Sikkim plantations. Broad and enlightened views have superseded minute and illusory calculations as to prices current, and trade profits. This hopeful result was due in no small degree to the action of Mr. A. O. Hume, C.B., the Secretary to the Government of India in the Department of Revenue, Agriculture, and Commerce.

Lord Mayo saw the necessity for great and general improvement in the agriculture of India, and he intended to effect this through the machinery of a Director-General, or at least of a Department of Agriculture. His statesmanlike design, so fraught with benefit to India, was thwarted by the India Office. A department was formed, but it was overloaded with work unconnected with agriculture, and was made almost powerless for good. Mr. Hume worked hard and unceasingly, bringing his great agricultural knowledge to bear on current questions; and, among other subjects, chinchona cultivation received his careful attention.

Mr. Hume saw that two millions of Her Majesty's subjects were annually dying in India of low malarious fevers, of which fully half might be saved if we could put the chinchona febrifuge retail into every *pánsarí's* shop at 1 rupee per ounce. He calculated that ten tons a year at least should be forthcoming, or, on an average, 100 grains per man. Mr. Hume felt strongly on the subject, because he had had great practical experience of malarious fevers; because he had proved, in thousands of cases, that the chinchona febrifuge is a real remedy; and because we had triumphed over the cultivation difficulty, and could, at comparatively very moderate cost, ensure in ten years a bark crop sufficient to produce the ten tons required. He felt that nothing stood between us and the saving of countless multitudes from death, or grievous suffering, but an economical process of manufacture; and that, rightly considered, this is infinitely more important than any other question before the Government of India. It involves simply the possible saving of a million lives and of an immensity of suffering such as few can adequately realise. He urged that nothing should be allowed to come in the way of this great work, that it should not be paltered with, but that it should be taken in hand at once, in the very best way that could be discovered, and with the ablest instruments money and trouble could procure.

The advocacy of the true objects of the enterprise from such a quarter was most opportune. It led to the necessary measures, with a view to the manufacture of

a cheap preparation in the Sikkim plantations. There are obvious advantages in the adoption of this course. The freight of the bark to Europe is saved, as well as the manufacturer's profit, and the return freight. On the other hand, there is the cost of materials for the manufacture, which can all be procured in India.

The object of eventually supplying the febrifuge direct from the plantations ought never to be lost sight of, and must be recognised as the final aim to be constantly kept in view. If our efforts fail now, they must be repeated until they succeed. If, after all, a cheap form of the febrifuge can be more economically procured from England at this moment, it must be so procured while such an abnormal state of things continues. But the final aim must be the direct supply of this necessary of life to the millions of India, from the plantations in India.

In June 1873 Mr. C. H. Wood, a scientific analytical chemist, who had also had charge of the laboratory and manufacturing department of a large firm of wholesale druggists, was appointed quinologist to the Government of India, for service in the chinchona plantations of British Sikkim. In the instructions which I drew up for Mr. Wood's guidance, I impressed upon him that his principal duty was to discover the best and cheapest form in which an efficient febrifuge can be extracted from the chinchona bark, and to superintend the manufacture of such febrifuge on a large scale. I explained that he would be expected to conduct analyses of bark, with a view of putting the cultivation

of chinchona on a really sound and scientific footing. Such analyses were to be directed to the discovery of the kind of bark which naturally yields most alkaloid in the climate of Sikkim, at what seasons, and under what conditions of soil, exposure, elevation, temperature, and cultivation.

Mr. Wood arrived at Calcutta in October 1873, and proceeded to Rungbi, where a bungalow was fitted up as a chemical laboratory. His first report was submitted in August 1874. He analysed specimens of *C. succirubra* from different elevations, finding a yield of total alkaloids of from 6 to 8 per cent.; and he also detected, in all of them, the presence of a new alkaloid called *quinamine*, which had recently been discovered by Dr. Hesse, and which only occurs in Sikkim bark. The *C. Calisaya* bark has since yielded a very large percentage of quinine. The *C. micrantha* trees yielded 4·8 per cent. of alkaloids. As regards manufacture, Mr. Wood decided upon adopting the method advocated by Dr. De Vrij.* The general nature of the process is to exhaust the dry bark by successive treatment with dilute hydrochloric acid, and to precipitate the resulting liquor with an excess of caustic soda. The precipitated alkaloids are collected in filters, washed, dried and powdered. This product is then dissolved in

* Dr. De Vrij made the suggestion that the bark should be worked up into a febrifuge medicine on the spot, in a letter to the Under-Secretary of State for India, dated October 30th, 1872. He said, "For this manufacture nothing is wanted but water, hydrochloric acid, and caustic soda; and, by their judicious application, 1000 lbs. of green bark will yield from 15 to 16 lbs. of mixed alkaloids." See Blue Book IV. p. 126.

a quantity of acid just sufficient to take up the alkaloids, filtered from some insoluble colouring matter, and the solution again precipitated. After washing, drying, and grinding, a fine white powder is obtained, which, however, acquires a slight buff tint by keeping. It never agglutinates in any way, even in the trying climate of India. It is freely soluble in weak acids, and is readily taken up by lemon-juice, which constitutes a pleasant vehicle for its administration.

The manufacturing operations in the Sikkim factory were commenced in 1875. The method recommended itself for its economy. No fuel is wanted, except what may be required to dry the alkaloid obtained; no expensive machinery is involved, the only plant needed is some wooden tubs and calico filters; the ingredients are acid and caustic soda, and no skilled labour is necessary.

Up to the end of 1876 the yield of dry bark of *C. succirubra* had been 321,236 lbs. The yield for 1876 alone was 211,931 lbs. For 1878 it was 344,225 lbs. The crop is taken partly by coppicing and partly by uprooting. The plantations are now capable of yielding 366,000 lbs. of dry bark annually, containing an average of 4 per cent. of total alkaloids. The cost of growing 1 lb. of bark, including interest on capital, is 5*d.*

The manufacture amounted to 48 lbs. of the febrifuge in 1875, to 1940 lbs. in 1876, to 3750 lbs. in 1877, to 5612 lbs. in 1878, and to 7007 lbs. in 1879. The cost of production is Rs. 3 per lb.

It is calculated by Mr. Wood that, by the rough process at present adopted, about 10,000 lbs. of chinchona febrifuge or *quinetum** can be annually issued.

During 1879, 128,000 ounces of this product were disposed of. This, at 1 rupee an ounce, cost £12,800. The same quantity of quinine, at 12*s.* an ounce (its present price), would have cost £76,800 ; a clear saving of £64,000.

The Sikkim *quinetum* has been submitted to a careful trial by the physicians attached to the Calcutta hospitals, and has also been tried in the Burdwan fever with great success. The conclusion of the Surgeon-General of the Indian Medical Department, on May 16th, 1877, was that in the *quinetum* "we possess a remedy perfectly suitable in the treatment of an enormously large percentage of the ordinary intermittent fever met within the autumnal season throughout the Presidency." Consequently, he directed that only one-quarter of the usual indent for quinine should be drawn, and that the remaining three-fourths should be made up with the Sikkim chinchona febrifuge. He strongly recommended that a similar rule should be adopted for the indents of all Government dispensaries.† Out of 1819 cases, 1752 or 96 per cent. were cured, in

* Dr. De Vrij has given it the name of *quinetum*. The termination *etum*, in Latin, denotes a collection. *Arboretum* is a collection of trees, *Pinetum* of pines. *Quinetum* similarly designates a collection of quina alkaloids.

† This recommendation was adopted in an order of the Government of India, dated June 12th, 1878.

an average time of under three days, with average doses amounting in all to 46 grains for each case.*

A complaint was made that the *quinetum* had the effect of producing nausea, but it was found, by experiments conducted at the Hague by Dr. van Tienhoven, at the request of Dr. De Vrij, that, if administered in doses not exceeding 10 grains (which includes two grains of an amorphous alkaloid producing the nausea), it has no unpleasant effect. It is easy to remove the nauseating principle from the *quinetum*, but this amorphous alkaloid is itself a perfect febrifuge, it is thoroughly innocuous if not administered in too large doses, and therefore Dr. De Vrij was of opinion that it is not desirable to increase the expense of production by eliminating it.

Dr. Vinkhuizen, the physician to His Majesty the King of the Netherlands, has administered *quinetum*, and could observe no difference between its action and that of quinine; and Mr. Whiffen now manufactures the *quinetum* extensively for use in England.

There are many points to be decided, and matters of detail to be worked out by the light of experience. But eventually the great object will be fully attained. A good beginning has been made in Sikkim, thanks to the powerful intervention of Mr. Hume, to the zeal and ability of Dr. King, and to the scientific skill and resource of Mr. Wood. We now see a febrifuge, manufactured in India, supplied to the people at a cost of one rupee per ounce, and the same policy, con-

* Dose, three to five grains.

tinuously followed, will secure an inestimable and permanent blessing for the vast multitude of sufferers.

Mr. Wood returned to England in September 1879, but his method of manufacture is so simple that it is carried on with perfect success by the natives, who have been trained by him under the supervision of a gardener at the plantations.

The next step will be to establish a factory, on a suitable scale, in the most advantageous position that can be found in India; for the purpose of manufacturing crystallised sulphates of the febrifuge alkaloids from *C. succirubra* and *C. micrantha* barks, and sulphate of quinine from the *C. Calisaya* bark. The amorphous alkaloids and all impurities will be eliminated. The crystallised sulphate will be sold at the same price as the present *quinetum*, and will thus be brought well within the means of all classes of the people, while the quinine will be sold at market prices and will help to cover the expenses. The factory will be utilised in preparing other things required by the medical department, so that general economy may be promoted and good interest paid on the capital outlay.

This measure will, if steadily and continuously persevered in, be the means of permanently securing the great objects for the attainment of which I introduced the cultivation of Peruvian bark into India.

CHAPTER XV.

FINANCIAL SUCCESS OF THE ENTERPRISE.

IT is a gratifying incident connected with the introduction of chinchona cultivation into India that it should be a complete financial success. The object of the introduction was to bring a chinchona febrifuge within the reach of the mass of the people. If it had cost half a million to accomplish this object, the money would have been well spent. But it has not only cost nothing, it is a most profitable and remunerative public work. Its collateral results have been the repayment of all the sums expended upon it with interest, the realisation of a large annual profit to the State, the establishment of a valuable product in India, the addition of a fresh means of profit to the resources of Ceylon, and the creation of a new and important source of bark supply for the European markets.

The great demand for quinine in India shows how serious the question of bark supply was becoming. During the eight years from 1867 to 1875 the quantity of quinine sent to Bengal in compliance with Government indents was 33,345 lbs., worth £116,707; to Madras, 5764 lbs., worth £20,174; and to Bombay, 7252 lbs., worth £25,382; a total for all India of 46,364 lbs.,

worth £162,263. The yearly demand was, on an average, 5151 lbs. of quinine at an annual cost of £18,000. Besides the Government indents, 5000 lbs. of quinine are annually imported into India; so that the whole demand is 10,000 lbs. a year, worth about £40,000.

The introduction of chinchona cultivation and the manufacture of the febrifuge in India, will, in a few years, effect a sensible reduction in these figures, while the febrifuge will be brought within the reach of multitudes who now need, but cannot get it.

If we turn to the sources of bark supply, other than the East Indies, we find that they are five in number. Of late years, by far the most important has been the Republic of Colombia, which furnishes, in very large quantities, the barks known in commerce as "*Soft Colombian*," "*New Grenadian*," and "*Pitayo*." From 1875 to 1880 the quantity of these barks which reached the London market was 16,778,800 lbs. During the last few years the quantity of Colombian bark has increased from 2,000,000 lbs. in 1877, to 4,200,000 in 1878, 5,700,000 in 1879, and 6,909,860 in 1880.

The second source is from the Peruvian ports of Arica and Mollendo, being the product of Bolivian forests. The total export of bark from Mollendo, in 1878, was 1,375,200 lbs. The latest prices were 2*s.* to 4*s.* 6*d.* From June 1879 to June 1880 the quantity of Calisaya bark, from South America, that was sold in the London market, was 512,200 lbs.

The third source is from the ports of Payta and

Guayaquil, consisting of crown and ashy crown bark from the Loxa and adjacent forests. The average of the last five years has been 270,000 lbs. a year; but in the year 1879–1880 the quantity sold in the London market was 332,640 lbs. It fetches from 1*s.* to 2*s.* 6*d.*

The Peruvian port of Pacasmayu is the fourth source whence the bark is shipped, which is known in the trade as "Mossy Lima"—probably from the forests of Huanuco and Huamalies. In five years, 804,020 lbs. of "Mossy Lima" have arrived. In the last year (1879–1880) the quantity was 78,190 lbs. It fetches very low prices, from 6*d.* to 11*d.*

Lastly, a small quantity of red bark comes from Guayaquil, fetching prices up to 10*s.* a lb. In 1879–1880, the quantity that arrived was 36,000 lbs.*

The whole quantity of bark from South America, in the London market, from June 1879 to June 1880, was :—

From Colombia	6,002,330 lbs.
Calisaya	512,200 „
Crown and Ashy Crown . . .	332,640 „
"Mossy Lima"	78,190 „
Red Bark	36,000 „
	6,961,360

From Colombia 6,002,330 lbs., and from all other South American sources 959,030 lbs.†

* In 1878 the total export of bark from Guayaquil amounted to 1,988,000 lbs., worth £59,400. Of this quantity 914,500 lbs. went to England, 141,200 lbs. to the rest of Europe, and 924,300 lbs. to the United States.

† Some of the Peruvian bark is brought down the river Amazon and exported from Pará. The quantity, by this route, was 82 tons in 1873, 44 in 1875, and 56 in 1876, worth £12,300.

Let us now see what place the East Indian barks take in the London market. In 1868 a small quantity of Government bark was sold for £2815. In 1872 bark began to come from India in considerable quantities, and the arrivals have steadily increased. In that year the Government bark fetched £333 8*s.* 6*d.* In 1873 as much as 23,641 lbs. were sold for £429 13*s.* 5*d.* In 1878–79 the Government bark sales showed a profit of £35,293. From June 1879 to June 1880 the Government Nilgiri plantations sent 207,400 lbs. of bark to the London market. In the same period the private plantations of the Nilgiris and Wainad sent 74,800 lbs., the Sikkim plantations 271,300 lbs., and Ceylon 289,160. Some of the bark, both from the Nilgiris and Sikkim, fetched over 10*s.* a lb. Java sent 70,088 lbs. to Europe.

Including the 329,400 lbs. used in the Sikkim factory, the yield of Peruvian bark from India and Ceylon was, in 1879–80, 1,172,060 lbs. The sources of supply of bark to the London market, from all parts of the world, stand in the following order :—

Colombia	6,002,330 lbs.	1879–80	
India and Ceylon	1,172,060	„	„
South America (except Colombia)	959,030	„	„
Java *	70,088	„	„
Jamaica	about 21,140	„	„

Thus the East Indian source of supply is now the most important next to Colombia, and stands second as regards quantity. But as regards quality, it is by far the most important of all. In 1877 some renewed

* To the Amsterdam market.

Officinalis bark from the Nilgiri plantations was sold at 15*s.* 8*d.* per lb., the highest price ever obtained. In January 1879 some of the East Indian renewed crown bark, from Mr. Rohde's plantation, sold at 9*s.* 1*d.* per lb., and in the following March some lots sold at 14*s.* 1*d.* per lb. In March 1879 Government barks from the Nilgiris sold at 11*s.* 10*d.* per lb.; and in June 1880 Calisaya bark from Sikkim fetched 10*s.* 10*d.* In 1880, also, a small parcel of Ceylon bark was sold at 10*s.* per lb. South American barks seldom attain to such prices.*

At the same time Indian chinchona cultivation has been the main cause of the manufacture of a cheap form of the febrifuge in Europe, and has thus been productive of immense benefit to the civilised world. The conclusion of the Medical Commissions in 1866, with regard to the almost equal efficacy of the four chinchona alkaloids, led to their production in an inexpensive shape. Mr. Whiffen, of the Battersea Quinine Works, now manufactures *quinetum*, a preparation containing the pure alkaloids of East India red bark, in large quantities, and it is coming into use in our hospitals.

The result of the sales of bark from the Government chinchona plantations on the Nilgiri Hills is that a sum of £173,046 has been realised. The total cost of the whole enterprise from the commencement, including

* The Bolivians have quite recently begun to cultivate Calisaya trees, and in 1880 Messrs. Jenkin and Phillips sold some cultivated Calisaya quill bark from Bolivia at 14*s.* 6*d.* per lb.

interest, was £129,628 in 1876. By the year 1879, allowing for charges during intervening years, the sum to be debited against the enterprise was only £38,942. In 1880 the whole capital account had been paid off with interest, and the plantations began to yield a clear annual profit.

It is, therefore, true of the chinchona enterprise that, as a mere commercial speculation, it has paid off the whole outlay, including introduction of the plants, cultivation, and interest; and has become a complete financial success. This was not my object. It is merely a gratifying incident, and a good test of efficient work. The true result is that great harvests of Peruvian bark are annually gathered in British India, and that the febrifuge has been brought within the reach of the mass of the people.*

* It has been suggested by a writer in the *Pall Mall Gazette* of September 18, 1880, that China will hereafter be among the largest and most constant customers for cheap febrifuge alkaloids from British India. From the vast tracts of country in China where rice is cultivated, fever is never absent. Opium is now employed as the medicine easiest to be had and the cheapest. If chinchona alkaloids could come into competition with opium, and obtain the preference by their lower price, the immense superiority of chinchona over opium as a febrifuge would produce a revolution in the Chinese consumption of the two drugs. By this process a solution would be found for the dangers and uncertainties of the large opium revenue of India, and for the perplexing moral questions connected with it.

APPENDIX A.

CAOUTCHOUC CULTIVATION IN BRITISH INDIA.

In 1870 I came to the conclusion that it was necessary to do for the india-rubber or caoutchouc-yielding trees what had already been done with such happy results for the chinchona trees. The area of yield of caoutchouc is far more extensive than that of febrifuge bark. While the trees yielding the febrifuge alkaloids only grow wild on the slopes of the Andes, and all belong to one genus, the caoutchouc-yielding trees are of several genera, and are found in the forests of India, the Eastern Archipelago, Africa, Madagascar, Mexico, and Nicaragua, as well as in South America. But the same danger threatens the one product as had threatened the other. Owing to the enormous demand for caoutchouc, the most reckless felling is now going on in all the tropical forests which yield this valuable product. The time has come when plantations must be formed of caoutchouc-yielding trees, in order to prevent

their eventual destruction, and to provide for a permanent supply.

The increase in the demand for india-rubber is very remarkable, and the enormous number of uses to which this product is now put, renders the consideration of measures for its cultivation, and for securing the permanency of an adequate supply, a question of great moment. In 1830 only 464 cwt. of india-rubber were imported into this country. In 1840 the quantity had increased to 6640 cwt.; and in 1846 the duty on india-rubber of 1*s.* per cwt. was repealed. In 1857 the quantity had further increased to 22,000 cwt.; and in 1874 there were 129,163 cwt. imported into this country, worth £1,326,605. In 1878 the quantity imported into England was 149,724 cwt., worth £1,313,209. Caoutchouc is now used for an infinite number of purposes. Wherever steam-power is employed, either on shore or afloat, it is impossible to do without india-rubber. It is required as packing for the piston-rods and glands of the engines, valves for the pumps, washers for making joints, belting for driving the shafting, hose and tubing for conveying steam and water, buffer-springs for railway carriages, and many other such purposes too numerous to mention. When it is considered that every steam vessel afloat, every railway train, and every factory on shore employing steam-power, must of necessity use india-rubber, it is hardly possible to overrate the importance of securing a permanent supply, in connection with the industry of the world.

For purposes connected with telegraphy this product is also now extensively used. It is employed as the insulating material for submarine, subterranean, and aërial cables. In the hard form of ebonite it is employed for insulators to carry the iron wire along the posts, as well as for battery cells, for the electro-magnetic coils, and in many parts of telegraphic instruments in place of the more expensive article, ivory. India-rubber is also used for waterproof clothing, carriage aprons, fishing stockings, diving dresses, water and air beds and cushions, door mats, ground sheets in camping out, and tubing. India-rubber elastic thread is largely used in the form of webbing, by the Leicester, Derby, and Nottingham manufacturers. India-rubber is necessary, too, for life-saving apparatus, for surgical instruments and appliances, and for hose, gas-tubing, and innumerable domestic purposes, including door-springs, and, just now, a great many rings for the rinking skates. Ebonite—which is the form of india-rubber vulcanised hard by the addition of extra sulphur, so that it can be turned in a lathe and made into articles of any form or shape—is used very extensively for combs, photographic baths and trays, syringes, taps and tubing for aquaria, and in chemical works.

Such being the infinity of purposes which give rise to the demand, it will easily be understood how bravely the work of destruction is being carried on. In British India there is an indigenous caoutchouc-yielding tree, which should be brought under cultivation on the spot.

But there are other kinds in other parts of the world, and it became necessary, in the first place, to ascertain whether they are superior to the caoutchouc in British India; for, if so, their introduction would needs be an essential part of any scheme for initiating the cultivation.

The caoutchouc-yielding trees grow in a zone on each side of the equator, encircling the globe, but by far the richest and best source of supply is in South America. It was M. de la Condamine, the leader of the expedition to measure an arc of the meridian near Quito, who first gave an accurate description of caoutchouc, and of the tree from which it is procured. The tree is the *Siphonia* or *Hevea*, which grows in all parts of the basin of the Amazon, and yields the Brazilian caoutchouc. This is the best and most abundant, and is known as Pará india-rubber. The *Hevea* is a euphorbiaceous tree.

On the western side of the equatorial region of South America, in Ecuador and Colombia, on the isthmus of Panama, Central America, and Mexico, the india-rubber tree belongs to the *Castilloa* genus, so named after Don Juan del Castillo, a Spanish botanist, who died in Mexico in 1793. The native name of the tree in Mexico is *ulé*. The *Castilloas* belong to the family of *Artocarpaceæ*, of which the bread fruit and jack tree, and the *anjeli* of India, are members. It is worthy of note that the *Artocarpaceæ* are closely allied to the *Moraceæ*, the fig tribe, to which the caoutchouc trees of India belong. The *Heveas* and *Castilloas* are the india-rubber trees of the New World.

In India the *Ficus elastica*, a tree so named by Dr. Roxburgh in 1810, which yields caoutchouc, is found in the forests which border the valley of the Brahmaputra, in the province of Assam. The family of *Apocynaceæ* includes the other caoutchouc-yielding trees of Asia and the eastern islands—the *Chavannesia* of British Burma, the *Urceola* of Borneo, and the *Vahea* of Madagascar, as well as the *Landolphias*, which produce the caoutchouc of Africa.

In commencing caoutchouc cultivation in India, it was in the first place necessary to take stock of all existing knowledge on the subject, and in the second place to ascertain whether any of the other kinds were intrinsically superior to the *Ficus elastica*, because if this proved to be the case, their cultivation in India would also be desirable.

With these objects in view, I intrusted the duty of making the necessary researches and investigations to Mr. J. Collins, formerly curator of the Museum of the Pharmaceutical Society, who drew up a very able and exhaustive report on the subject in 1872. The conclusions then arrived at were that the establishment of plantations of *Ficus elastica* should at once be undertaken in Assam; but that the caoutchouc from the *Heveas* and *Castilloas* of South America was superior to that of the *Ficus*, and that consequently those trees should be introduced into British India.

The first step, therefore, was to commence the cultivation of the native Indian caoutchouc tree, which is found in the forests along the northern and eastern

boundaries of Assam, as well as in the low valleys of the Naga and Jaintia hills to the south. The *Ficus elastica*, like the banyan and other trees of the same genus, has aërial roots, and is of an epiphytical habit. When wild in the forests it often commences its growth in the fork of another tree, which it eventually overshadows and destroys. It grows to a great size, and one tree planted at Tezpur in Assam, 36 years ago, is 112 feet high, the diameter of the crown measures 140 feet, the circumference of the central mass of aërial roots surrounding the stem is 70 feet, and it has over a hundred aërial roots, the largest of which measures six feet in girth. The forests containing *Ficus elastica* are excessively moist in the rainy season, and they remain moist all through the dry season with a temperature of about 98° in the shade. The trees thrive best under conditions of excessive moisture and great heat, but with good drainage.

Hitherto the caoutchouc has been collected in Assam by men of the wild tribes, who cut every part of the tree they can get at, and allow the milk to flow into holes made in the ground. The collectors are encouraged to obtain the largest possible quantity during the shortest possible time, without any regard to future supplies. This has led to the most outrageous wholesale destruction of these valuable trees, by felling them so as to render the operation of tapping more convenient. Messrs. Martin and Richie, who had a lease of the caoutchouc yield at Tezpur, are said to have given it up before their time expired, because the supply had

diminished so much that their business was no longer remunerative.

So that no improvement of the yield can be expected from private enterprise, except at the risk of exhausting the remaining sources of supply; and it is consequently necessary to place the collection of caoutchouc in Assam under the control of public officers who have an interest in the protection and improvement of the forests; and to commence the formation of plantations of *Ficus elastica* on a large scale, and in accordance with a well-considered plan. Dr. Brandis, Inspector-General of Forests in India, strongly urged the necessity of these measures in 1872; and good progress has since been made, under the superintendence of Mr. Gustav Mann, the Conservator of Forests in Assam.

The first attempts, which were started in July 1873 in the Darjíling Terai and in the Goalpara district of Assam, were failures, but in July 1874 Mr. Gustav Mann took charge of the experiment with very satisfactory results. Three plantations have been formed. One, on the right bank of the river Kulsi, in the Kamrúp district of Assam, consisted of 95 acres in 1879, on which were 2895 plants. Another is at Charduar, at the foot of the Himálayas, 18 miles north of Tezpur, in the Darrang district of Assam, where there were 685 acres under cultivation in 1879, the growth of the trees being excellent and most vigorous. The third plantation is at Bamuni, also near Tezpur,

Here there were 8 acres planted with 459 trees in 1878; but the climate is too dry. No artificial shade is now given, and the young trees are healthy and vigorous. Experiments are in course of trial, to plant the *Ficus elastica* in strongly made baskets placed in the forks of trees, and on grass lands, as well as in the regularly prepared beds. The trees may be tapped at the age of 25 years. After 50 years they will yield 40 lbs. of caoutchouc every third year, worth £3 4*s*. In Cachar the india-rubber tree was discovered in 1862, and 750 cwt. were collected, the yield being increased to 1500 cwt. in 1863. The yield from the first tapping is 35 to 40 lbs. The tree is then untouched for three or four years, and the second tapping yields much less. Mr. Edgar reports that the Cachar forests would yield 2000 cwt. annually. In 1879 the quantity of caoutchouc exported from India was 10,033 cwt., valued at about £61,685* Besides extending the cultivation of the trees, the officers in charge of the plantations will carefully investigate all such questions as the most favourable time of the year for tapping, and the best methods for collecting and preparing the caoutchouc.

* Caoutchouc exported from British India during the last six years:—

1874—16,837	cwt.	valued at	£117,775
1875—19,893	„	„	£108,618
1876—15,258	„	„	£97,861
1877—13,308	„	„	£90,169
1878—13,794	„	„	£89,381
1879—10,033	„	„	£61,685

The experimental cultivation of the *Ficus elastica* has thus been satisfactorily commenced in India, under the able superintendence of Mr. Gustav Mann.

Another caoutchouc-yielding plant belonging to the *Apocynaceæ* has recently been discovered in British Burma, and reported upon by Mr. Strettell of the Forest Department. It is the *Chavannesia esculenta*, a creeper which it has hitherto been the object of foresters to extirpate, as injuring the growth of the teak trees. Some of these creepers, growing near Rangoon, have a girth of 18 inches round the stem, while the crown covers an area of 200 square feet, at a supposed age of five years. It may be propagated either from seeds or cuttings; and instructions for its cultivation have recently been published in the *Indian Agriculturist*. The estimated result of cultivating trees 30 feet apart over an area of 400 acres, or in all, 19,200 creepers, is that there will be an annual yield of 19,200 *viss* (a *viss* is about 3½ lbs.), which at Rs. 200 per 100 *viss*, will give Rs. 38,400 a year. After the first year, the cost of cultivation will be very slight, and the profits will begin to come in after seven years.

As regards the cultivation of indigenous kinds of caoutchouc-yielding trees in British India, it will thus be seen that the initiatory steps have already been taken. The second, and not the least important part of the undertaking, is the introduction of plants yielding a better kind of caoutchouc, from other parts of the world, but especially from South America.

The most valuable trees, and those which now yield by far the largest quantity of india-rubber, are the *Heveas* of the Amazon valley, called Pará, from the port of shipment. We learn from Keller that, during the last few years, both the quantity and the value of india-rubber exported from Pará have been steadily increasing. In 1874 England received 56,580 cwts. of Brazilian caoutchouc, worth £720,000 ; the average price being 2*s.* 6*d.* to 3*s.* a lb. Next to the Pará rubber in value and yield, comes that obtained from the *Castilloa* trees, which grow over a much wider area of South and Central America. The quantity of *ulé* or *Castilloa* caoutchouc imported into England in 1874 was 24,286 cwts., worth £287,413, at 2*s.* a lb. Thus out of the whole import of 129,263 cwts., 70,866 come from South America.

The remaining 38,775 cwts. are divided among British India, Borneo (1*s.* 9*d.* a lb.), Africa (1*s.* 5*d.* a lb.), and Madagascar (2*s.* 3*d.* a lb.) But the South American source of supply is, beyond comparison, the most valuable, and the cultivation of *Castilloa* and *Hevea* trees in India is an important part of the undertaking.

Several reasons led me to the decision that a collection of the *Castilloa* seeds should first be obtained. As the *Castilloas* grow over a much more extensive area than the *Heveas*, where there is a greater variety of soil and climate, it is more certain that suitable sites for their cultivation would be found in India and Burma. They belong, too, to the *Artocarpaceæ* which are so well represented in India, especially on the Malabar

and Travancor coasts, by the jack trees, and the *anjeli*, of which wood all the canoes are built.

The *Castilloa* trees flourish in all the equatorial forests on the west coast of South America, and in 1878 the quantity of india-rubber exported from Guayaquil was 6561 cwts., worth £22,963.* The trees also abound all over the isthmus of Darien, where they are being destroyed most recklessly, in Central America,† and in the southern states of Mexico. In Ecuador the india-rubber is called *heve;* in Mexico and Central America the Aztec word *ulé* is used.

The trees, which are the giants of equatorial American forests, belong to two species, the *Castilloa elastica*, and that which Mr. Collins has named *Castilloa Markhamiana.* They thrive in dense steaming and warm forests, and are particularly abundant in the valley of the San Juan de Nicaragua, where it rains for nine months in the year. In Nicaragua the yield is said to be about 10,000 cwts., giving employment to 600 *huleros* or collectors. From Carthagena, Guayaquil, Panama, and Vera Cruz, are exported supplies of *ulé* india-rubber, the greater part of which goes to the United States; but it has been seen that as many as 24,286 cwts. arrive in this country.

The collection of *Castilloa* plants for introduction into India was a very difficult service, for the trees

* This shows a large falling off. In 1873 it was 16,635 quintals, and in 1874, 10,690 quintals, In 1876 it again rose to 10,138.

† From San José de Costa Rica, 78,231 lbs. of india-rubber were exported in 1878. The quantity is not given for Guatemala, but the value is stated as $1540 in 1878.

grow in wild and unhealthy forests, with no means of transit, and no facilities of any kind. In Mr. Cross I found a man with all the requiste qualifications for undertaking it. He is an excellent gardener, possessed of great energy and determination, combined with judgment, is acquainted with the language, and has had much experience in South American travelling. No better man could be found to execute the difficult task of obtaining a supply of *Castilloa* plants, and conveying them in a healthy state from their native forests to the gardens at Kew.

Mr. Robert Cross left England on the 2nd of May, 1875, and reached Panama on the 26th of the same month, my instructions to him being to endeavour to make the collection on the isthmus. He found that great destruction was going on among the *ulé* trees in all parts of the Darien isthmus, the native collectors cutting down the trees in order to tap them more easily, as is the case in the Assam forests. After obtaining all the information that could be procured in Panama, Mr. Cross determined to select the forests on the banks of one of the large tributaries of the river Chagres as the base of his operations.

He ascended the Chagres river in a canoe, and then made a journey on foot through the dense forest, into the heart of the *ulé* district. He found the *Castilloa* saplings growing on the banks of streams, with their roots often running down to the edge of the water. They abound in rich soil along the base of the hills, and are also met with on the summits of ridges; every-

where, except in swampy ground. The trees, which proved to be of the species named by Mr. Collins *Castilloa Markhamiana*, are from 160 to 180 feet high, with a diameter of 5 feet, and a yield of 100 lbs. of india-rubber. The wood is spongy and soft, and decays rapidly when bruised or injured. Many of the leaves measure fourteen inches in length, and seven inches in breadth. The temperature of the forests ranges from 75° to 80° Fahr., and they are excessively damp. The range of the *Castilloas* is so wide that, in some places, the trees must flourish in climates which at one time of the year are dry. It is probable, however, that the species with the best and largest yield of caoutchouc flourish best in a hot and very damp and steaming atmosphere, like that of the forests of the isthmus.

Mr. Cross collected 600 plants, and also drew a quantity of milk, in order to prepare a specimen of the rubber. The sample he brought home was examined and reported upon, and was pronounced to have much less impurity than is usual for this kind of rubber, and thus proved Mr. Cross's plants to be of the best species. He left the isthmus with the plants on the 6th of September 1875, on board the mail steamer *Shannon*, but in the morning of the 8th, when going 13 knots an hour, the vessel ran on the Pedro reef of rocks, off the coast of Jamaica, and her bows were immovably fixed upon them, while the stern continued to bump heavily for many hours. The rest of the passengers left the ship in boats, but Mr. Cross

stuck manfully by his plants and was eventually taken on board H.M.S. *Dryad*. He came home in the mail steamer *Nile*, reaching Southampton on the 2nd of October. Considering all the extraordinary difficulties of the undertaking, it reflects great credit on Mr. Cross that he should have been successful, and thus have performed an important public service with ability and sound judgment. There were soon 134 of Mr. Cross's *Castilloa* plants in a flourishing condition at Kew Gardens, and in the course of 1876 a good supply of *Castilloas* was forwarded to India, to form the nucleus of a series of plantations.

Thus the introduction of one out of the two valuable South American species was provided for.

It remained to take measures for obtaining plants of the most valuable kind of all from the valley of the Amazon—the *Hevea* yielding the famous Pará india-rubber of commerce.

The *Heveas* are of several species, and, like the *Castilloas*, they are large trees growing in humid tropical forests. Dr. Spruce, who is the highest authority on this genus, considers that the cordilleras of the Andes separate the *Castilloas* from the *Heveas*, and that the caoutchouc-yielding trees to the eastward of the Andes are of the latter genus. They extend up to the very foot of the mountains, and I have myself passed some time among *heveros*, collecting for local use in the *montañas* of Paucartampu and Laris. While in Peru and Ecuador the india-rubber is called *heve*, in

Brazil the name is *seringa*, and the collectors are *seringueiros*. Eight species are enumerated by Collins, namely:—

Hevea	*Brasiliensis*	(Müll.)
„	*Spruceana*	(Müll.)
„	*Discolor*	(Müll.)
„	*Pauciflora*	(Müll.)
„	*Rigidifolia*	(Müll.)
„	*Benthamiana*	(Müll.)
„	*Lutea*	(Müll.)
„	*Guyanensis*	(Aube.)

The *Hevea Brasiliensis* is the species which prevails round Pará, and the forests of the lower Amazon; *H. Spruceana* is met with round the mouth of the Tapajos, and the other species occur on the banks of the Rio Negro and Casiquiari; but the genus is far from having yet been thoroughly studied.

In the Pará district of the lower Amazon, very little rain falls from August to February, the heaviest rains being in May and June; and the temperature varies between 74° and 95° Fahr.; the mean of a year being 81°. The Amazon valley is remarkable for uniformity of temperature, and for regular supply of moisture; the dry season extending from June to December, and the wet from January to May. In the Upper Amazon the atmosphere is densely vaporous.

Our latest authorities on the Pará caoutchouc are Mr. Wickham and Mr. Franz Keller. The latter traveller, writing in 1874, says that the *hevea* trees on the shores of the Amazon have nearly disappeared, owing to the destruction and death of trees, the places of which have never been filled up. But the forests of

caoutchouc-trees on the banks of the Madeira, Purus, and other tributaries, yield over 1,600,000 lbs; while the yield of the whole of this colossal river basin amounts to 12,800,000.* Keller laments the fact that no attempt is made, in the Amazon district, to cultivate these useful trees; which, owing to frequent tapping and rough treatment, suffer much and die soon. The *seringueiros* have to go farther and farther into the interior, to seek fresh trees in undiscovered valleys. It is to be feared that, owing to the indolence of the mestizo population, and the short-sightedness of the Brazilian Government, measures of conservancy will not be adopted until too late.

The *Castilloa*, like the *Ficus elastica*, though requiring a very humid climate, will only thrive when there is drainage at the roots. But Keller says that the *Hevea* yields the largest supply of milk when, during the annual inundation, its stem is at least five feet under water.

The scene presented by an encampment of caoutchouc collectors is extremely picturesque. Their huts are lightly built among the trees, and round them tower the majestic *mosqueteiro* palms, and the lofty *Bertholletia*,† while in front is the gleaming river with

* Keller gives the following statement of the export of caoutchouc from Pará :—

1865 — 256,967	arrobas.	
1866 — 291,091	„	
1867 — 301,170	„	
1868 — 334,975	„	
1869 — 365,354	„	(4558 tons).

† *Bertholletia excelsa* yields the Brazilian nuts.

its sunny sandbanks. From the huts narrow paths lead through the dense undergrowth, cut by the axe of the *seringueiro*, to the lonely caoutchouc-trees. The collector makes small holes in the bark, to which tubes of clay are fixed, which lead the milk into bamboo receptacles; going from tree to tree he collects these bamboos, and on his return to the hut the contents are poured into the carapace of a large tortoise. The milk is then subjected to the process of smoking without delay, for if left standing too long the resin separates. In this process the milk is subjected to the smoke of the *urucuy* or nuts of the *Atholea excelsa* palm, which alone, it is said, possesses the power of liquefying. An iron pot, without a bottom, and with a narrow neck like a bottle, is placed so as to form a chimney over a heap of these burning nuts, and the white steam rises in masses through the narrow opening. The *seringueiro* pours a small quantity of the white fluid, of the consistency of thick milk, from a calabash over a light wooden shovel, as evenly as possible, and then rapidly thrusts it into the white steam. The milk soon takes a greyish-yellow colour, and becomes firm. Then they add layer upon layer, until the caoutchouc on each side of the shovel is about 8 inches thick. The *plancha* or slab is then finished, taken off the shovel by cutting down one side, and hung up in the sun to dry, as there is a good deal of water between the layers. The colour of the *plancha* is at first a light silver-grey, but by degrees becomes yellower and yellower, until it turns the dark colour known in commerce; a practised hand

can, in this way, manufacture 5 or 6 lbs. in an hour. The thicker and freer from bubbles, the better the quality and the higher the price. The cheapest is called *surnamby* or *cabeza de negro* (negro-head), and is made from drops found at the foot of the trees and from the refuse in the vessels. The export of caoutchouc from Pará in 1876 amounted to 6493 tons, worth £955,000.

There are two other india-rubber trees of South America of less value, whence come the Pernambuco and Ceará rubbers. The Pernambuco is an apocyneaceous tree, *Hancornia speciosa*, known as the *mangiaba* by the natives, and is found in the provinces of Rio de Janeiro, Bahia, Pernambuco, and Goyaz. It is a small tree about the size of the apple, and is more valued for its fruit than for its caoutchouc, which is not much collected. The Ceará tree (*Manihot Glaziovii*) is more important, especially as it flourishes in a dry climate.

For obtaining plants yielding the india-rubber of Pará and Ceará I was again so fortunate as to secure the services of Mr. Cross; who left Liverpool on June 19th, 1876, and reached Pará, at the mouth of the Amazons, on July 15th. He found, on inquiry, that the great field for caoutchouc collecting was the province of Pará, and the islands formed by the delta of the river, especially Marajo. The land round Pará rises from the bank of the river southward in gentle undulations, cut by deep gully-like natural ditches called *gapós*, which often penetrate for many miles into the interior of the vast forest region, and are filled daily by the tide. To those navigable by canoes the

term *ujarape* is often applied. The intervening land between the *gapós* owes its origin first to tidal deposits, and afterwards has been raised by the decayed remains of a long series of rank growths of vegetation. On the more elevated lands, beds of white sand 20 feet deep are met with, covered with a layer of decayed vegetation. In every direction the country is a mass of dense exuberant forest.

Mr. Cross explored this region, in order to make observations on the soil, climate, and mode of collecting and preparing the rubber. On the 2nd of August he was following the tracks of the rubber collectors through the dense forests ankle-deep in mud, until he came to a wide *gapó* into which the tide flowed. It was connected with many lesser watercourses, forming a kind of network over a whole district of forest, the most elevated parts of which were only raised three to four feet above the highest tides. India-rubber trees grew along the margins of the streams, and Mr. Cross observed three, the trunks of which were flooded to a height of a foot. Most of the others occupied dry situations. The *gapós* are lined with soft rich mud, and the exhalations from such places, shrouded by a forest growth of 80 or 100 feet high, always produce attacks of fever. Mr. Cross measured a few of the largest trees, all of which had been tapped for periods varying from five to fifteen years, and found their circumference, one yard from the ground, to vary from 3 feet to 6 feet 10 inches. Regularly tapped trees do not exceed 60 feet in height.

Mr. Cross went on with the work of collecting plants, and established them at once in cases. In this way he made a collection of 1000 plants in four cases. The range of the thermometer from July to October was from 72° to 92°. On the 17th of October, 1876, the collection was shipped for Liverpool, and Mr. Cross proceeded, in the same steamer, to the Ceará region. He landed in a heavy surf, on a kind of raft called *jangada*, and found himself in a very different country from that of the Amazon.

South of the Amazonian forest, there is a region known as the *Sertão* or wilderness; extending in a broad belt from the Parnahyba river to the São Francisco. The province of Ceará is within this belt—a high rolling plain, broken by abrupt elevations and chains which are, in fact, outlying fragments of the great central table-land of Brazil. The only high forest is found on these mountain sides, the summits and the plains below being occupied either by thin forest growth, or by pastures and sandy tracts, with groves about the river courses. From June to December the climate is extremely dry, and the streams and rivers disappear, except along the mountain sides. The rains, at times very heavy, come in December and January. The principal commerce of the country is in hides and jerked beef; and there are plantations of sugar, coffee, and cotton, along the mountain sides. In 1877–78, Ceará was visited by a terrible drought and famine, when about half the population perished.

Ceará is connected with a place called Pacatuba,

forty miles inland, by a railway made to facilitate the transport of sugar and cotton. It traverses a flat and parched country, covered with thickets of thorny bushes, and slender myrtles and *Leguminosæ*. Here and there clumps of the *carnaùba* palm (*Copernicia cerifĕra*) rise high above the other trees and bushes. The crowns of these palm-trees, waving with the wind, are visible over a wide expanse, and the back ground is formed by a range of mountains. Mr. Cross stopped at a village called Maracanahú, about 30 miles from Ceará, where he obtained a guide to take him to the india-rubber trees. The forest was tolerably high, but the sparse small foliage did not afford much shade from the fierce rays of the sun. Neither grass nor weeds grew under the trees, and there was an entire absence of ferns, mosses, and other plants. Mr. Cross concluded that the Ceará rubber-tree would thrive perfectly over a very wide area of the drier regions of British India. At first sight the tree resembles a birch, and the outer bark comes off in the same way, in thin silvery peelings. The largest tree was about 50 feet in height, with the trunk about a foot in diameter. Having found some young plants, Mr. Cross had great difficulty in uprooting them. The roots have tubes the size of kidney potatoes which adhere with great tenacity to the soil. After diligent search and very severe labour eighteen plants were collected, and brought safely on board the steamer. Thus in one day Mr. Cross was able to discover the origin of a tree hitherto unknown and undescribed, yielding an important

article of commerce, and at the same time to secure a number of plants. Next day he again went to Maracanahú, and obtained 42 more plants and 700 seeds.

Mr. Cross arrived at Liverpool on the 22nd of November, 1876, and his valuable collection of plants was deposited at Kew the next morning, consisting of a thousand plants of Pará rubber-trees (*Hevea Braziliensis*) and forty-two Ceará plants.

Thus all the valuable caoutchouc trees of South America had been obtained, and were ready for experimental cultivation in India; but the Government was very lukewarm on the subject, and I considered it most safe to send them, in the first instance, to the Ceylon gardens at Pérádeniya. From that centre their cultivation could be extended to India hereafter, when its importance is better appreciated by the authorities. The Ceará plants (*Manihot Glaziovii*) arrived from Kew in October 1877, and grow admirably in the Pérádeniya and Henaratgode gardens. They have produced ripe seeds; and plants have already been sent to Calcutta, Madras, Burma, and the hot districts of Ceylon, for trial. The *Hevea* also grows extremely well. A few trees are already nearly 30 feet high, with a girth of 14 inches. Already 500 *Hevea* plants, raised from cuttings, have been sent to Madras and Burma. The *Castilloa* trees grow well at Pérádeniya, still better at Henaratgode. Some are 16 feet high, with a girth of 16 inches. The increasing demand for caoutchouc must eventually convince the

Government of the great importance of its systematic cultivation. The Pará rubber is the best and choicest, the Castilloa will grow over the largest area in the moist belts, and the Ceará thrives on the drier and hotter plains.

A writer in the *Indian Forester*,* after reading Mr. Cross's Report on the Castilloa region, pointed out the ghât forests as far as the Nagar division of Mysor as the most likely region to constitute a new habitat for the Castilloa trees. He says :—

"In the interesting account of the *Castilloa elastica* in the last number of the *Indian Forester*, the low forests about Coimbator and the base of the Nilgiri Hills are recommended as the locality in India where it is perhaps most likely to succeed. Were the writer acquainted with the line of ghât forests extending from thence northwards as far, say, as the Nagar division of Mysor, we feel confident, after a careful perusal of his notes, that he would place his finger on this region as the most likely to constitute a new habitat for his species. Alter the names, and his description of the climate, soil, and general surroundings of the forests where his caoutchouc tree grows will exactly suit that of the lower valleys of the ghât range. Indeed, looking at the map of the world with our knowledge of winds and rain in the tropics, were it otherwise a very fertile brain would be required to strike out a plausible explanation of the fact. As it is, we know from the general accounts of

* Vol iii. p. 57. (July 1876.)

travellers that there is a very striking resemblance between the two regions. Where the difference lies, and that a great one, is in the two floras. In the ordinary course of things there can be no doubt about one's ability to grow *Castilloa elastica* in the lower ghât valleys, but the point which nothing but experiment on the spot can determine is, whether in this tract of teeming fertility and bewildering wealth of species, it can so far intrude on the closely fitting vegetative economy as to conquer an independent position in the forest flora. Most probably it would require some artificial aid to maintain itself, but if its economic value is anything like that stated, this we can afford to give it. Only to a limited extent though, for the same poisonous climate exists here as in the tree's New World habitat. Up to this limit great facilities for working exist. The region we are speaking of is permanently inhabited by aboriginal tribes, who sometimes settle down into villages in healthy localities, at other times retire to the most lonely and malarious portions of the belt where they seem to be dying out, and who sometimes can be depended on for regular work, at other times not. With or without their aid, labour for a portion of the year could be easily got from the settled and healthy country above. Very often villages with surplus labour exist on spurs of the ghâts almost overhanging the low country, in a cool and non-malarious climate two or three thousand feet above the sea. Here the forest officer has his hut, and rides up after the day's work is done.

Back here too he brings his fever-stricken coolies for a change of air, better than any medicine. The whole forest region below is now pierced by easy ghât roads at intervals of about 50 miles—the ports of Mysor, as the talented engineer who made most of those in that province has aptly described them. All the most accessible passes are lined by a dusty streak along which the produce of the up-country passes to the sea. In a word, in the lower ghât forests we can offer *Castilloa elastica* a habitat quite as unhealthy as its own in America, and an amount of care and culture it could not get there.

"Away from the trunk roads and the valleys abutting to them, minor forest produce should be attended to.

"It is a question whether the existent minor forest produce could not profitably be more extensively worked; it is certain that the successful introduction of *Castilloa elastica* would unmistakably turn the scale in the right direction. We would not, however, have it thought that we staked bringing down the trembling beam on this one species. Many others will occur to everybody, but *Castilloa elastica* seems to open up a fairer prospect than them all. There is our old, now familiar friend, *Ficus elastica*, which seems likely to grow well enough here, provided we kept down hardier native species; probably it would require a good deal of aid in this way. There is also *Hevea elastica*, and in fact the whole series of caoutchouc-yielding trees, not forgetting the wonderful Burmese climber, *Chavannesia esculenta*. Since, however, *Castilloa elastica* admittedly

produces one of the finest india-rubbers, one would naturally wish to begin by trying that. Considering the inaccessibility and unhealthiness of the lower ghât forests, we seem to have a case here of what our forefathers would have described as a providential adaptation of ways to means, in the fact that the locality is nevertheless so well fitted to produce an article, so necessary in the arts, and of such a growing application, as caoutchouc."

While the *Castilloa* will find a new home in the western ghâts, the *Heveæ* is introduced into one of the moist zones of India, the *Ficus elastica* is cultivated in its native forests of Assam, and the *Chavannesia* in Burma, the *Ceará* rubber, with quite a different habitat and requirements, may be extensively grown on the hot dry plains of Eastern India. This measure, if intelligently and continuously followed up, will thus ensure, in the future and as the demand increases, a regular and large supply of the best kinds of caoutchouc from British India.

APPENDIX B.

INTRODUCTION OF THE CULTIVATION OF PERUVIAN COTTON INTO BRITISH INDIA.

WHILE travelling in the Coimbator and Madura Collectorates of the Madras Presidency, I was struck with the resemblance of the climate, in many respects, to that of the coast valleys of Peru. This part of India appeared to me to be adapted for the cultivation of the species of cotton which is indigenous to the Peruvian coast valleys, while it seemed unlikely that North American cotton could ever be extensively raised, to advantage, in so dry a climate.

North American cotton will not thrive in a very dry climate, as a certain amount of moisture in the atmosphere, throughout the year, appears to be an essential condition for its successful growth. This kind of cotton has a very different constitution from the Indian; it cannot stand so much drought, and the conditions required for its culture are an equable and moderate supply of moisture throughout all the stages of its growth. These conditions are fulfilled in the Dharwar country in the Bombay Presidency, where a

considerable quantity of moisture is retained in the atmosphere during the cold season, when other parts of the Bombay Presidency are intensely dry; and there the North American cottons succeed; but they will not yield remunerative crops where this is not the case. The indigenous plant, on the other hand, is able to endure the dry season well, being a native of the arid country of Sind and part of the Punjab.

I, therefore, thought it might be useful to introduce a cotton with a longer staple than that of the indigenous plant of India, and consequently better suited to the wants of manufacturers, which would thrive in the dry climate of the Collectorates on the eastern side of the Madras Presidency. The Peruvian cotton meets this requirement.* Its staple is longer than that of New Orleans, Pernambuco, and much longer than any indigenous Indian cotton, though shorter than Egyptian or "Sea-Island." The respective lengths of the staples of different kinds of cotton, compared with Peruvian, are as follows :—

Species of cotton.	Minimum. Inches.	Maximum. Inches.	Mean. Inches.
"Sea Island"	1·41	1·80	1·61
Egyptian	1·30	1·52	1·41
Peruvian	1·10	1·50	1·30
Brazilian	1·03	1·31	1·17
New Orleans or "Uplands"	0·88	1·16	1·02
"Uplands" grown in India	0·95	1·21	1·08
Indigenous Indian cotton .	0·77	1·02	0·89

* Peruvian cotton had not before been introduced into India. The so-called Peruvian cotton which had been tried (*Gossypium Peruvianum*), as mentioned in Dr. Royle's work, was procured from the Brazils, and is quite a different kind, growing in a very moist climate, and under conditions distinct from those of the real Peruvian cotton.

The Peruvian cotton plant is indigenous and perennial, and was cultivated by the subjects of the Grand Chimu, and afterwards by those of the Yncas in the coast valleys, long before the discovery of Peru by the Spaniards. They irrigated their cotton-fields by means of channels conducted from the rivers and reservoirs, picked and cleaned the cotton, and wove it into cloths. The ancient Peruvians used a machine for cleaning their cotton, which closely resembled the Indian *churka*. It consisted of two rollers, about the thickness of a finger, with handles at opposite ends, which turned them different ways. The wool was pinched through by degrees, and as the seeds could not pass between the rollers, they were stripped off, and dropped outside.

The long strip of coast line between the Andes and the Pacific Ocean, extending from 21° 48′ S. to the river Tumbez in 3° 35′ S., a distance of 1400 miles, consists of a sandy desert, intersected by chains of rocky barren hills, and traversed by about sixty rivers and streams, with as many fertile valleys on their banks. This region is bounded inland by the western cordillera of the Andes, and varies from twenty to sixty miles in breadth. The coast valleys, thus surrounded by sandy deserts, which extend from the foot of the Andes to the shores of the Pacific, are the native land of the Peruvian cotton.

The climate of this region is very peculiar. Rain in large drops is unknown, and the northern part especially is exposed to a long season of excessive dryness. The summer or dry season extends from November to April,

when there is usually constant dryness, a clear sky, and considerable, though not oppressive, heat. From June to September the sky is obscured for days and even weeks together by fog (*niebla*), often accompanied by drizzling rain (*garua*), the thermometer rarely falling below 50°. The wind never exceeds a gentle breeze all through the year. At the time when it is driest and hottest on the coast, it is raining heavily on the Andes. In the Department of Piura, the most northern on the Peruvian coast, the climate is modified by the lower latitude, and also by the vicinity of the forests of Guayaquil. Fog is almost unknown in the plain, *garua* is not frequent, but positive heavy rain falls at intervals of several years, from February to April.

The most southern cotton district of importance is in the province of Yca, in latitude 14° S. I visited the cotton-growing valleys of Yca, Palpa, San Xavier, and Nasca in this province. In Yca there were three mills for cleaning cotton worked by water, and I stayed at two prosperous cotton estates in the valley of San Xavier, with good machinery for cleaning the cotton, and powerful screw presses. In the valleys of Nasca and Palpa there were country-made cleaning machines, but also worked by water-wheels. The rivers run nearly dry in January with the thermometer often at 80° and 90°, but the mean yearly range is from 65° to 85°. Don Domingo Elias was the great landed proprietor of Yca and San Xavier at the time of my visit. The cotton was conveyed on mules to the port of San Nicolas, which was a great distance from the estates, and where the landing

was very bad. I therefore made a survey of another port 28 miles north of Cape Nasca, and only about 30 from the cotton estates, where the landing was better. I piloted an English barque into this new anchorage, and she was loaded with cotton brought down by mules, each one carrying two bales of 175 lbs. each.

North of Lima are the cotton producing valleys of Casma, Chiclayo, Truxillo, Jequetepeque, and Lambayeque. This part of the Peruvian coast enjoys an equable climate, with a mean temperature ranging from 70° to 84°.

The supplies of cotton-seeds which I obtained for India, came from Yca, and in larger instalments from the northern province of Piura. All authorities unite in describing the climate of Piura as excessively dry and hot. From November to May the thermometer ranges from 80° to 96°, the atmosphere is dry, and the glare from the sandy and stony soil excessive. If a piece of paper is put on the ground in the evening, it may be taken up and written on in the morning, for it will be found to be quite dry. Owing to the brilliancy with which the celestial bodies shine in this season, it has become proverbial to say "as clear as the moon of Payta." During this season, however, the rains fall in the upper region of the Andes, and the two rivers of Piura and Chira are therefore full. In the moist season, from May to November, the *garuas* are much more scanty than in the valleys farther south, and there is very little dew. The mean temperature is then from 70° to 81°.

In the valley of the Chira there are fruit gardens consisting of cocos, dates, mangoes, oranges, limes, lemons, alligator pears, and tamarinds. The crops are plantains, yucas of two kinds, sweet potatoes, and many garden vegetables. In the time of the Yncas there was a most perfect system of irrigation by means of reservoirs in the hills for storing water, and numerous aqueducts. The population of the Chira valley, soon after the Spanish conquest, was 193,000 souls. Two centuries afterwards, in 1785, it had dwindled down to 44,497.

The Spanish conquerors found the cotton plant and fabrics of cotton almost everywhere among the native tribes, the species being the *Gossypium Barbadense* of Linnæus. Mummies disinterred from Peruvian *huacas* or tombs are wrapped in cotton cloth, and underneath, the body is occasionally found enveloped in the brown cotton which was considered sacred by the Peruvians. In a crop of *G. Barbadense* a percentage of the plants almost always yields cotton of a reddish-brown colour with a short and brittle staple, so that it is a mere degenerate sport from the white. Yet the tint was pleasing to the Indians, who held it sacred, and limited its use to the Yncas and priests, and to their dead. The cotton was raised by the Indians of Catacaos, Piura, Colan, and the Chira valley, who have each their small plot of land by the river side.

The cotton is planted either in the *vega* where it gets an annual watering from the rise of the river, or on the adjacent low land where the plants have to be watered

by hand until their roots penetrate to a good depth. Sowing is generally done just after the floods have subsided and left the *vega* dry in April, and nine months afterwards the first crop is ripe. The plants receive no further care, except to facilitate the access of the water to their roots at the time of the annual floods, and they are never pruned. Yet, after the first crop, they yield again every six months, and go on bearing cotton for six or seven years. Then the cotton begins to deteriorate, the bushes are stubbed up and the ground resown.

Formerly the women and children picked the cotton when ripe, and, to clear it from the seeds, they took it out on the desert, selected a place where there was only clean white sand, and beat the cotton on it with slender sticks, one in each hand, until it was quite separated from the seeds. Then, with a slight shake, every grain of sand fell out, and the cotton remained a white felty sheet called *madeja*. It was then sold for exportation. Lately this very simple process has been superseded by North American gins set up at Piura and on the Chira.

In 1861 Mr. Stirling purchased a tract of land on the Chira below Amotape, and began to set up machinery and make irrigation canals. Mr. Garland and Don Pedro Arese also projected a large cotton estate at Monte Abierto, near Tangarara, in the Chira valley. Dr. Spruce resided for some time at Monte Abierto, and, at my request, drew up a most valuable

and interesting report on the Piura cotton.* Monte Abierto is in 4° 53′ S. and 80° 56′ W.; a plain of about 400 acres covered with luxuriant cotton plants, which are surrounded on three sides by woods of *algarroba* (*Prosopis horrida*), and bounded on the fourth by the Chira river. The engine-house, gin-house, and ware-houses stand about a hundred yards from the river, the water being conveyed to the engine in a canal. The engine for working the pumps is of 25-HP., and the fuel is *algarroba* wood. A centrifugal pump has also been set up, by which means all the plants can be watered once a week, or oftener if necessary.

The Peruvian cotton tree grows to 15 feet in height, with a trunk 6 inches in diameter, ascending alternate branches, and soft brittle wood. It would probably live twenty years. But it is usually cultivated as a shrub, its growth beyond easy reach of the pickers being checked by breaking off the leading shoots. It sends down a very long tap-root, and the lateral roots are usually few and short. The Piura cotton (*algodon de Piura*) is a shrub generally considered to require from nine to ten months to mature its first crop. Afterwards it produces every six months. When two or three years old, good plants have yielded in one crop 8 to 12 lbs. of cotton, and even 18 lbs. About 130 bolls give 1 lb. of cotton. The plants usually stand about 15 feet apart,

* *Notes on the Valleys of Piura and Chira in Northern Peru, and on the Cultivation of Cotton therein*, by Richard Spruce, Phil.D. (London, 1864), 8vo. pp. 81.

and in three years they begin to interlock. From the fifth year the yield degenerates in quality and quantity, and at the sixth or seventh the bushes are stubbed up and the ground resown. Taking the plants at 15 feet apart there are 193 to an acre, yielding 1544 to 2316 lbs. The Payta cotton is very white and soft, with a good length of staple.

Yca cotton (*algodon de Yca*) has the habit of Piura cotton, and can scarcely be distinguished from it; but it produces the largest pods with the most numerous seeds, and consequently the greatest quantity of cotton. The weight of the contents of an average boll of several kinds of cotton is as follows :—

	Cotton. Grains.	Seeds. Grains.
Yca	60	65
Piura . . .	54	75
Egyptian. . .	51	102
Georgia . . .	37	73½
New Orleans . .	28	50½
Sea Island . .	20½	50

I obtained supplies of seeds of Piura and Yca cotton in 1862 and 1863, and transmitted them to Madras and Bombay, where satisfactory trials were made. I advised that the cultivation should be undertaken in Coimbator, Madura, and Tinnevelli,* to which the Chairman of the Chamber of Commerce at Madras added the districts of Chèngalpat, Tanjor, and Rájmahendri. The great advantage that I anticipated from the introduction of Peruvian cotton into India was the profitable cultivation of a long-stapled and high-priced

* My Report is printed in the *Edinburgh Botanical Society's Transactions*, vii. p. 461.

kind in districts which, from their dryness, had hitherto only been found suitable for the short-stapled indigenous plant. Although the cultivation has not been extended over a large area, it has yet been undertaken in several districts, and the Peruvian plant has been highly spoken of by the agriculturists of Madras. It will probably be more widely appreciated in the years to come.

In the Bombay Presidency it is also cultivated, and I had the pleasure of seeing a most flourishing field of Peruvian cotton near Dharwar in 1866. In that year the Bombay Chamber of Commerce reported a sample of Dharwar-grown Peruvian cotton to be good, long and regular in staple, colour good, and the quality equal to the best selection of Dharwar. Mr. Walton, who did so much for cotton cultivation in Dharwar, reported that Peruvian cotton could be very extensively and successfully extended along the range of the western ghâts, in Canara, Ratnagiri, Colaba and Tanna, in the western parts of Dharwar, Belgaum, and Satara. Mr. Walton considered that irrigation was not necessary, and that the trees should be kept down to four feet by lopping. One great advantage of Peruvian cotton is that it is easily cleaned, the fibre separating from the seed with little trouble. Another is that it can be very economically cultivated, only wanting fresh sowing about every fourth or fifth year, and requiring no irrigation in India.

With these recommendations, Peruvian cotton will probably prove a useful addition to the products of British India.

APPENDIX C.

INTRODUCTION OF CUZCO MAIZE AND QUINUA INTO BRITISH INDIA.

THE Cuzco maize and the *quinua* of the lofty *punas* of the Andes are two cereals which are most valuable in their native land, and I, therefore, thought that their cultivation might usefully be introduced into British India. Cuzco maize is one great result of Ynca agriculture, one lasting proof of the civilisation of ancient Peru. Growing in the lofty valleys of the Sierra, it should find a new home on the lower hills of the Western Himálaya and on the Nilgiris. *Quinua* ripens in the highest inhabited parts of the Andes, and would flourish at similar elevations in the Himálayas.

Maize, as a cereal supplying millions of people with food, is one of the most useful gifts which the Old World received from the New. But the maize of Cuzco surpasses all other kinds in its yield and its excellence.

The earliest notice of this magnificent corn is from the Ynca Garcilasso de la Vega, who was born at Cuzco and brought up upon the Cuzco maize, and who

published his account of it in 1609. He says that what the Mexicans and people of the Antilles call *maiz*, the Peruvians know as *sara*. He adds that there are two kinds of *sara*. One is hard and called *muruchu*,* and this had been introduced into Spain. The other, called *capia*, is tender and highly esteemed. The Peruvians made different kinds of bread and cake from the maize. The sacrificial bread was called *çanca*, the festive bread *huminta*, ordinary bread *thanta*. The women ground the corn on broad slabs with a half-moon-shaped stone, working it up and down from one end to the other, and gathering it in, from time to time, with their hands. They also made fritters called *api*, boiled puddings called *muti*, toasted grains called *camcha*, and cakes. They made a fermented liquor from the flour called *acca* (now *chicha*), and a strong spirit called *sora* and *viñapu*, as well as vinegar. A good sugar was obtained from the stalk, the stalks and leaves were used as food for cattle, while the leaves of the cobs were in request for rubbing and smoothing stones for sculptors. The Ynca Garcilasso tells us that he saw all this with his own eyes, and was sustained and nourished on this *sara* until his nineteenth year.†

The Jesuit Acosta, who was in Peru from 1570 to 1586, speaks in admiration of Peruvian maize. He says it grows on stalks, each one producing one or two

* *Muruchu* is hard in Quichua. Acosta also mentions the two kinds of maize, one great and very nourishing, the other small and dry, called *morochi*. *Nat. Hist.* lib. iv. cap. 16.

† *Comm. Real*, Pt. i. lib. viii. cap. 9.

cobs, and that on some cobs he had counted 700 grains. It must be planted by hand, one by one and not very close together, and it is not uncommon to gather 300 bushels for 1 bushel sown, while the green leaves and stalks are used for food for cattle and mules.

The Cuzco maize is so called from being cultivated in the warm valleys in the neighbourhood of the ancient capital of the Yncas, but two to three thousand feet below the site of the old city. Its grand proportions are due to the careful agriculture of the Yncas during many centuries. The stalks grow to a height of 15 feet, and the grains are four or five times the size of ordinary maize grains. The grains were white (*colla-sara*), red and yellow (*cuma-sara*), yellow (*para-sara*), red (*micsa-sara*), purple (*matay-sara*); and there were double cobs of immense size (*sara-mama*), which were looked upon as sacred.

The year of the Yncas was regulated with reference to maize cultivation. In June the people were occupied with the irrigation channels. Then came the sowing, the ripening, and the harvesting, each with its solemn festival. In the month called *Ayrihuay* (April), they reaped and harvested the crops, singing a chant called *yaravi;* and the Ynca himself, with his nobles, assisted in reaping the crop on the *Colcampata,* beneath the fortress of Cuzco. These wise sovereigns held the science of agriculture in high honour.

Cuzco maize was and still is cultivated, in its greatest glory, in the lovely valley of Yucay, through which flows the river Vilcamayu. It should be grown

at heights from 8000 to 3000 feet above the sea. The Yucay valley is bounded on the east by rugged escarpments of bare rock, and lofty snowy peaks of the Andes, at the feet of which are the graceful *andenes* or terraced gardens. On the west is a lower but still lofty ascent, so that the valley is well sheltered and is gay with gardens, clumps of trees, and bright green fields. The climate is like that of Italy, or of Nismes in the south of France. Here the Yncas constructed those marvellous hanging gardens which bear testimony to the skill and taste of the designers, and where the Cuzco maize was gradually brought to perfection. The terraces are wider at the edges of the level ground, and as they ascend the mountain sides they become narrower until the topmost terrace, some 1000 feet above the valley, is scarcely two feet broad. The terrace walls are of rough stones, slightly inclining inwards, and varying in height, according to the slope of the mountain, from 3 to 15 feet. An *azequia* or artificial aqueduct, starting from the verge of the snow, is conducted through the *andenes*, whence water is led along each terrace. The terraces were filled with rich soil, from which every stone was removed, and here grew the noblest of all the varieties of Cuzco maize, the *yurac-sara* or white maize of Yucay. The palace of the Yncas, high up on one of the loftier terraces, was surrounded by the glorious maize of Yucay, and had a view from its halls, quite unequalled for combined loveliness and grandeur.

I determined that this historical cereal should be

introduced from that beautiful valley of the Andes, into those of the Western Himálayas. I obtained supplies of the Cuzco maize, in several instalments, through the kindness of Messrs. Antony Gibbs & Co., the first arriving in the end of 1874; and they were duly forwarded to the Government of India. Suitable sites would be found in the analogous valleys of the Western Himálayas and perhaps the Nilgiris, at a height of 8000 to 4000 feet above the sea. Cuzco maize would not succeed on the plains of India, or on the Eastern Himálayas, where the rainfall is too great. So the seeds were distributed for trial on the plains of India, and in the Eastern Himálayas; and elaborate reports were written on their failure.

Fortunately the Agri-Horticultural Society of India also sent seeds, in October 1875, to the Punjab for trial in the Western Himálayas, and Mr. Halsey of Mahdopur reported that the maize grew to a height of 15 feet, and that several cobs arrived at full maturity. Colonel Chamberlain, at Ranikhet, sowed 150 seeds at a height of 5950 feet above the sea, and they all germinated and grew to fine healthy plants 10 to 12 feet high. Of these, 118 bore exceedingly fine well-formed cobs, and only 32 failed to bear seeds. Colonel Chamberlain added that he never tasted anything better than the Cuzco maize. Lieutenant Pogson of Simla also raised plants from 12 to 15 feet high, and one grain weighed as much as five grains of the ordinary Indian corn, each stalk yielding four cobs. Four cobs of Cuzco maize were equal to 20 of common Indian

corn The stalk was found to be exceedingly rich in sweet juice.

The Baboo Milambar Moskerjee, Judge of the Chief Court of Kashmir, made some molasses from stalks of Cuzco maize in 1877, and he conceived so high an idea of its value as a sugar producer that, on August 9th, 1877, his Highness the Maharaja of Kashmir applied for 20 *máns* of seeds for trial. This quantity was accordingly supplied to him.

In a subsequent report Colonel Chamberlain said that the Cuzco maize was incomparably the finest variety he had ever seen, and that for table purposes there was nothing known to him equal to it. He added that it could be used as a most excellent and nutritious food for cattle. In 1877 he was very successful, and was able to send 3000 acclimatised seeds of Cuzco maize to the Agri-Horticultural Society of India. The Financial Commissioner of the Punjab, after these trials, came to the conclusion that Cuzco maize would grow well in the hill districts, and that it was recommended by a double quality, producing both grain and sugar. He considered that it would be desirable to introduce it in the outer hills of the Punjab, and applied for a large quantity of fresh seeds.

The next year Colonel Chamberlain sowed a quarter of an acre with 400 seeds, which produced 38,000 grains in magnificent cobs, and 680 lbs. of green stems. He pressed out 640 lbs. of stems in a sugar-mill, and boiled down the juice, which gave 15 *sírs* of raw sugar, or 4 lbs. of refined sugar and four bottles of spirits.

This sugar was of good market value for refining, worth 8*s.* to 14*s.* per cwt. If the proper methods had been used, from 10 to 15 lbs. of refined sugar, instead of 4 lbs., would have been obtained, which is a third the quantity produced from sugar cane. But the sugar is an extra product. In May 1880 Captain Pogson, at Koteghur, received red, white, striped, yellow, and purple Cuzco maize grains from Mr. Duthie of the Saharunpur gardens, which came up well, and in numerous instances the red Cuzco had hybridised with the ordinary kinds. The conclusion was that Cuzco maize might also be used to improve the ordinary Indian corn by hybridising; as the hybrids might be stronger while preserving the advantages of Cuzco maize.

The results of the trials in suitable localities have been that Cuzco maize flourishes in the Western Himálayas at heights from 8000 to 4000 feet, especially at Ranikhet; that it produces abundant seeds; that as a source of food it is excellent and five times as prolific as ordinary maize; that the stalks produce sugar of good quality, and are most valuable as food for cattle; and that the plant will be serviceable for hybridising with ordinary Indian corn. Thus the introduction of Cuzco maize into India has been a useful and successful measure.

I also determined to introduce the *quinua* (*Chenopodium quinoa*) into India. It is cultivated at very great elevations in the Peruvian Andes, and yields abundantly a small but nutritious food grain. It seemed probable that *quinua* would grow well, under

cultivation, at similar heights on the Himálayas, and might yield supplies of food in the lofty districts through which the trade routes pass to Eastern Turkistan and Tibet. There is a plant called *bathu* (*Chenopodium album*) in the Punjab, resembling *quinua*, but very inferior to it, which is used for food, and also as a medicine. It grows in the plains, and is not a hill product. There is also an amaranth called *bathu*. But there is no Indian plant occupying the position of *quinua*, as a source of food supply cultivated at very great elevations.

The earliest mention of the *quinua* grain of Peru occurs in the "Cronica" of Pedro de Cieza de Leon, an observant old soldier, who accompanied the army of La Gasca in his campaign against Gonzalo Pizarro in 1547. He says: "There is a food called quinua, the leaf of which is like an amaranth, and there are very small seeds, sometimes white and at others reddish. Of these seeds they make a drink, and also they eat them cooked, as we do rice." In another place he calls quinua the principal food of the people in the Collao of Peru.

The Ynca Garcilasso de la Vega, in the first part of his Royal Commentaries of Peru, also mentions the quinua plant. "Of the grains which are cultivated over the face of Peru, they give the second place to that called *quinua* by the natives. The plant on which it grows is very like the wild amaranth, in shape as well as in the leaf and the flower. Both the Indians and the Spaniards eat the tender leaves in their dishes,

because they are savoury and very wholesome. They also eat the grain in their soups, prepared in various ways. The Indians also make a beverage of the *quinua*, as they do of the maize, but only in districts where maize will not grow. The native herbalists use the flower of *quinua* to cure some diseases.

The brothers Ulloa, in the last country, thus describe the *quinua*:—"It resembles a lentil in shape, but is much smaller and very white. When boiled the grain opens, and out of it comes a spiral fibre, which appears like a small worm, but whiter than the husk of the grain. The stem is about 3 or 4 feet in height, and has a large pointed leaf. The flower is of deep red, and in it are contained the grains or seeds. The quinua is eaten boiled like rice, and has a very pleasant taste." *

Von Tschudi pronounces *quinua* to be a nutritious, wholesome, and pleasant article of food. The leaves, before the plant attains full maturity, are eaten like spinach. The seeds are boiled in milk, or in broth, and are sometimes cooked with cheese and pepper. The dried stems are used as fuel.

Quinua is cultivated in the higher parts of the Andes of Peru and Quito, and is the hardiest food grain in the world, growing at greater elevations above the level of the sea. In Quichua the cultivated plant is called *quinua*, the green leaves *lliccha*, the wild plant *azar*, pudding made of quinua grains *pisque*, and the boiled grains dried in the sun, and ground into coarse

* *Ulloa's Travels*, i. p. 290. *Velasco, Hist. de Quito*, i. p. 51.

powder for food on a journey, *quispiña.* There is a variety called *cañahua* grown extensively in the districts bordering on Lake Titicaca.

David Forbes describes the *quinua* seeds as exactly of the form and size of an ordinary mustard seed. "They are of a red, yellow, or white colour, in different varieties of the plant. The seeds must always be first well washed with water, to remove a bitter principle they contain, before cooking. When boiled they make an excellent porridge or pudding. The leaves of the young plant are eaten as salad, and a sort of fermented liquor is also made from them called *hupaccusa* in Aymara." *

This remarkable food grain might doubtless be usefully cultivated in the loftier districts of the Himálayas, near the principal trade routes, such as Ladak and Sikkim; and I thought that, with this object in view, seeds might be forwarded to Darjíling and Leh, and intrusted to responsible persons who would take an interest in the cultivation. The plant flourishes at heights from 12,000 to 16,000 feet above the level of the sea, and supplies of wholesome food might thus be obtained in regions where corn will not ripen.

Two cwt. of *quinua* and *cañahua* seeds were accordingly shipped from the Peruvian port of Mollendo on September 4th, 1874, and arrived at Liverpool in November, whence they were forwarded to India.

* *Hupa* is the Aymara word for *quinua.*

APPENDIX D.

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